APRIL
1946

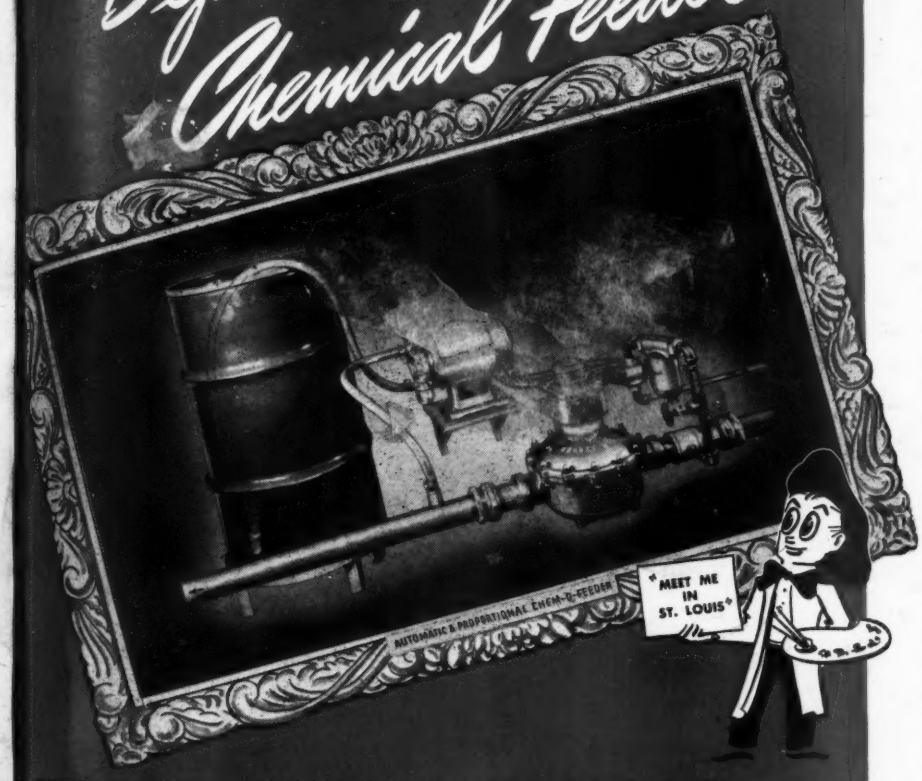
Public Works

IN THIS ISSUE:

- Preventing Scale and Corrosion
- Hot Asphalt Paving
- Industrial Waste Treatment

LIBRARY

Portrait of a Dependable Chemical Feeder



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96 CODDING STREET, PROVIDENCE 1, RHODE ISLAND

BOOTH NO. 7 MAY 6-10 AMERICAN WATER WORKS ASSOCIATION CONFERENCE

DESCRIPTION:

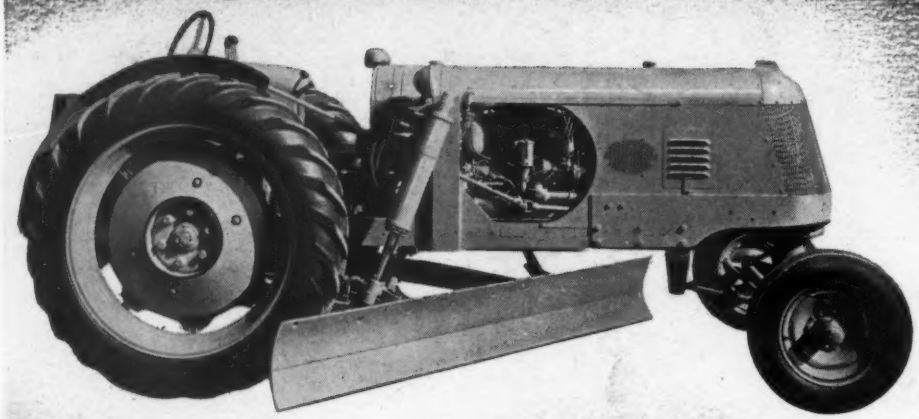
%Proportioneers% Automatic and Proportional Hydraulically Operated Chem-O-Feeders are used for gravity or other water supplies where the rate of flow may vary from minute to minute. These units inject hypochlorite or other solution in proportion to main flow and are operated by water power from the main itself, or can be furnished to operate by compressed air, steam, etc. The Chem-O-Feeder has a double diaphragm and is of the Treet-O-Control type with pilot valve and gear box mounted on the meter, the feeding unit being separate and only connected to the pilot valve by copper tubing. This means that at any time you can add one or more Chem-O-Feeders for feeding chemicals—such as aqua ammonia for chloramine treatment, aluminum sulphate, soda ash, etc., by merely connecting the new units to the operating control lines without duplicating gear box, pilot valve and control meter. All Treet-O-Control meters are furnished with register to measure total through put of water.

SPECIFICATION:

Standard, double diaphragm 4D2-5D3 units are for line pressures varying from 10 up to 100 lbs. max. per sq. in. Special low pressure units are available for pressures from 4 up to 15 lbs. max. per sq. in. Chemical delivery is adjustable while unit is operating by means of micrometer stroke length setting, from 0 to approximately 12 CC per stroke. Maximum capacity depends on maximum allowable stroking rate which for hydraulic operation is usually 30 strokes per minute. At 26 strokes per minute, 12 CC per stroke, delivery is approximately 5 gal. per hour or 11.2 lbs. chlorine per day using 1% calcium or sodium hypochlorite solution.

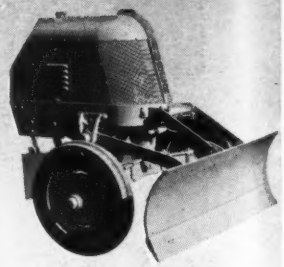
Write for Bulletin SAN-1

Versatile's THE WORD FOR THE HUBER MAINTAINER



ONE WAY SNOW PLOW

V TYPE SNOW PLOW

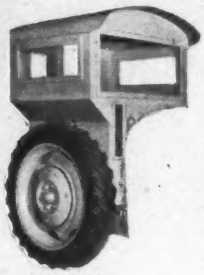


BULLDOZER

Here's an all-purpose machine which makes short work of year 'round street, highway and airport maintenance jobs . . . jobs so varied it's hard to believe a single machine could handle them successfully. Equipped with a 9' scraper blade for light sub-grading, the Huber Maintainer can be converted speedily via practical attachments into a bulldozer, snow plow, mower, sweeper, lift loader or patch roller . . . has plenty of power at the drawbar for hauling, too. To get better acquainted with this one-man "maintenance crew," write today for a Huber Maintainer specification sheet.

PATCH ROLLER

ROTARY BROOM



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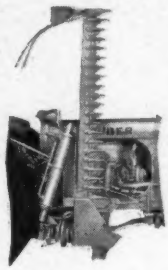

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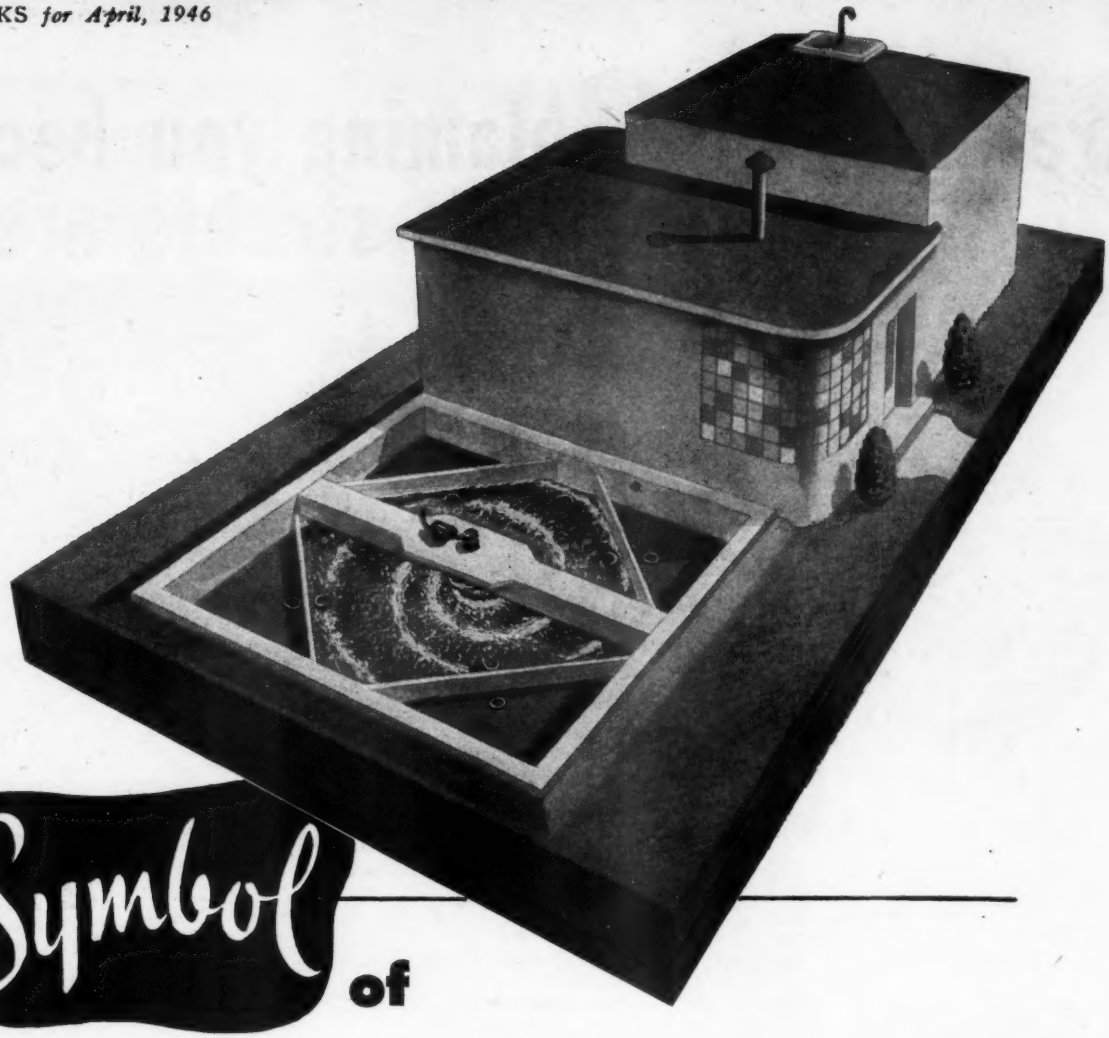
LIFT LOADER

THE HUBER MFG. COMPANY • MARION, OHIO, U. S. A.

HUBER

3 WHEEL & TANDEM ROLLERS

YEAR 'ROUND MAINTAINER



Symbol of a Community with the RIGHT IDEA

Aeration and final sedimentation in a single concrete structure of minimum dimensions . . . simple, smartly modern, proved efficient: that is the Yeomans "Aerifier" Package sewage treatment plant.

Tailored and "packaged" to fit specific needs, Yeomans "Aerifier" produces crystal clear effluent at exceptionally low over-all plant cost. It is ideal for small communities up to 3000 persons, and for isolated institutions and industrial plants.

Operation is simplified to a daily routine check. All units are open for visual inspection . . . clean, free from odors.

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A complete recommendation with construction cost estimates and application engineering will be furnished promptly on request.

Yeomans Brothers Company

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VOL. 77 PUBLIC WORKS No. 4
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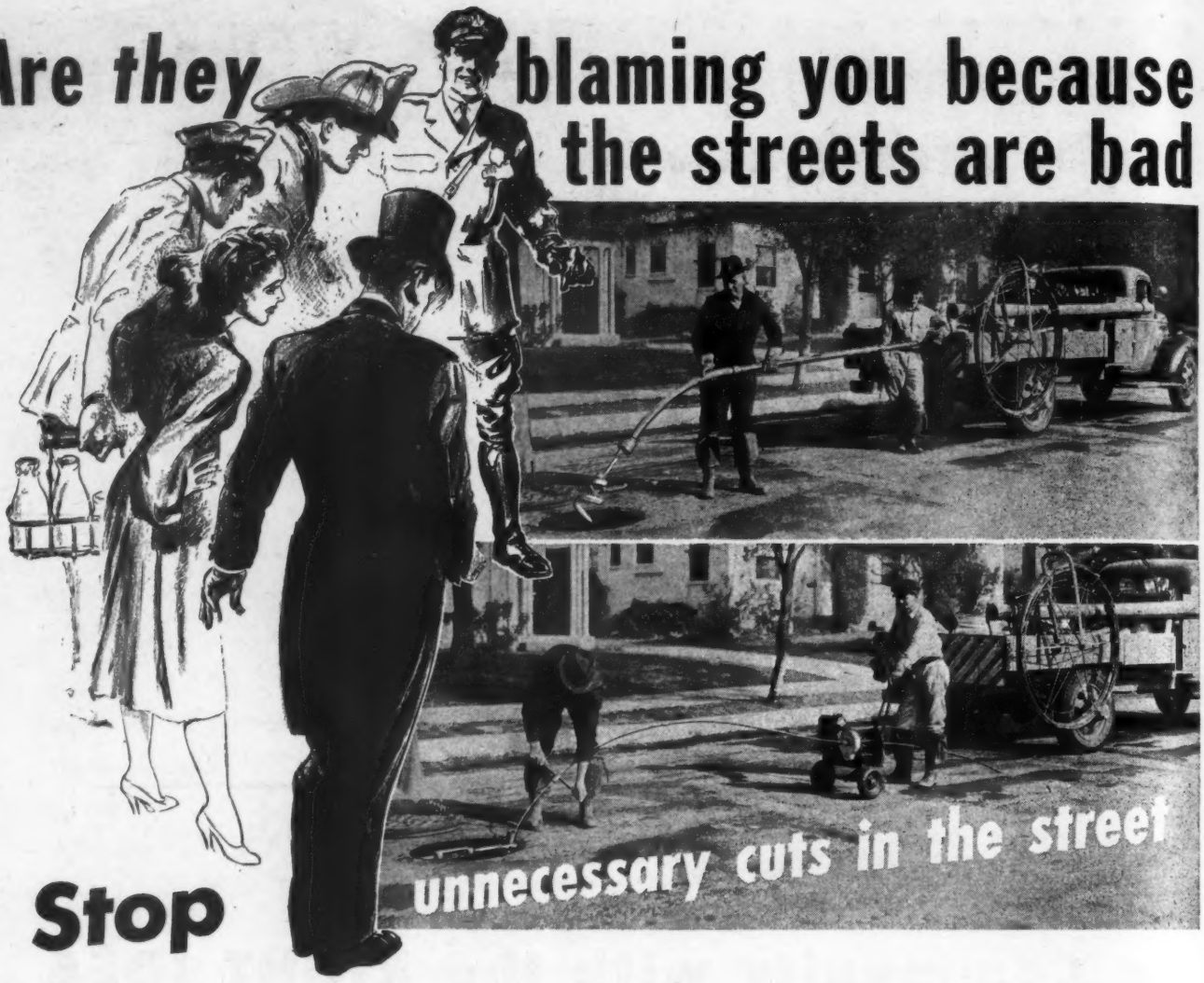
APRIL, 1946

Are they blaming you because the streets are bad



Patches in your city streets may be *Rough Reminders* that *obsolete pipe cleaning methods* are being used.

It's seldom necessary to tear up pavement when modern FLEXIBLE pipe cleaning equipment is used.

FLEXIBLES eliminate more than 50% of the "dig-ups" required by old outmoded methods. And when you figure costs, remember "dig-ups" are expensive.

Your Sewer Department can be modernized easily and economically with a Standard City Set of FLEXIBLE SEWER ROD EQUIPMENT. FLEXIBLES pay for themselves in a short time because they speed up work. A few men can clean more underground pipe than an entire crew working with old outmoded methods.

The "Flexible" Power Drive speeds work, operating on the same principle as ratchet turning handles, but turning rod into the pipe line continuously at about 5 times hand-turning speed.

No matter what the pipe cleaning problem is, FLEXIBLE can lick it. FLEXIBLE manufactures a complete line of tools for every type of pipe cleaning job — there are attachments for removing sand, roots, rocks, marine growths and any other pipe stoppages.

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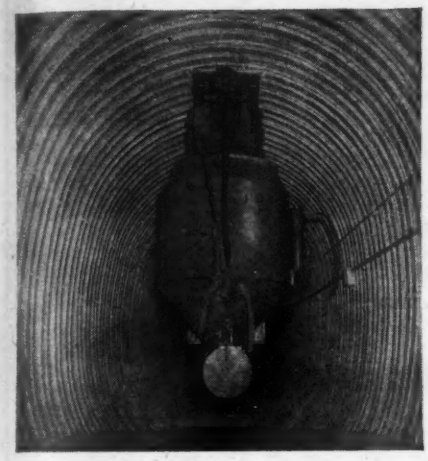
When you need special information—consult the classified READER'S SERVICE DEPT., pages 79-81

what designed strength can mean to your tunnel liner jobs



Rear view of weighing hopper. This elliptical batching tunnel of No. 10 gage Armco Steel is 11 by 13 feet and 460 feet long. Raw aggregates were stored over a 10-foot tunnel, 260 feet long, and wet sand over an 8-foot tunnel, 190 feet long.

This is how three aggregate tunnels built of ARMCO Corrugated Liner Plates helped speed construction of the Norfork Dam—a 1,500,000 cubic yard job.

First, the plates were easy to handle and install. Then, their designed strength permitted placing the tunnel directly beneath the aggregate pile, which attained a height of 60 feet. Delays caused by freezing in cold weather were avoided because the aggregate was handled from the bottom.

Armco's method of bolted construction made it a simple matter to locate the hoppers at any desired point. When the job was done the ARMCO Liner Plates were removed, nested together and stored in a minimum of space for future use.

There is a type and gage of Armco Plates to meet every tunnel condition. You can order exactly what you need for the job and the chances are you'll be "holing through" ahead of schedule. Write today for information on your specific needs. Armco Drainage & Metal Products, Inc., and Associated Companies, 1365 Curtis St., Middletown, O.

ARMCO

Tunnel Liner Plates

PUBLIC WORKS

Founded in 1896

Devoted to the interests of the engineers and technical officials of cities, counties and states

Vol. 77 No. 4

W. A. HARDENBERGH and A. PRESCOTT FOLWELL
Editors

APRIL CONTENTS

HIGHWAYS AND AIRPORTS

Grounds Maintenance and Vegetation for Airports, Highways and Park Areas 23
Earth Wearing Surface Does Not Impair Durability of Treated Wood Bridge Floor 24
Bangor Renews Its Streets With Hot Asphalt Paving. *By James L. MacLeod* 29
Four Point Program for Automobile Parking 47
Tackling the Parking Problem 48
Street Maintenance Practices 48
The Highway Digest 59

SEWERAGE AND SANITATION

Industrial Waste Problems and Treatment 25
Operation Records at Sewage Plants 30
Use of Proprietary Equipment and Processes in Sanitary Engineering 44
Provisions of Chicago's New Refuse Disposal Ordinance 48
Aluminum Paint in Sewage Plants 48
The Sewerage Digest 52

WATER SUPPLY AND PURIFICATION

Water Supply for the Stilwell Road. *By C. W. Christenson* 19
Scale and Corrosion Prevention by Chemical Conditioning of Water. *By R. T. Hanlon and D. Newton* 31
Denver Water Board Plans Enlarged System 42
Private Water System Pays City 48
The Water Works Digest 66

GENERAL

Capacity of Mowing Equipment 24
Publications on City Problems 58
Public Works Equipment News 74
Useful Booklets 78
News of People 78
Reader's Service Department 79
Jobs Available for Engineers 82

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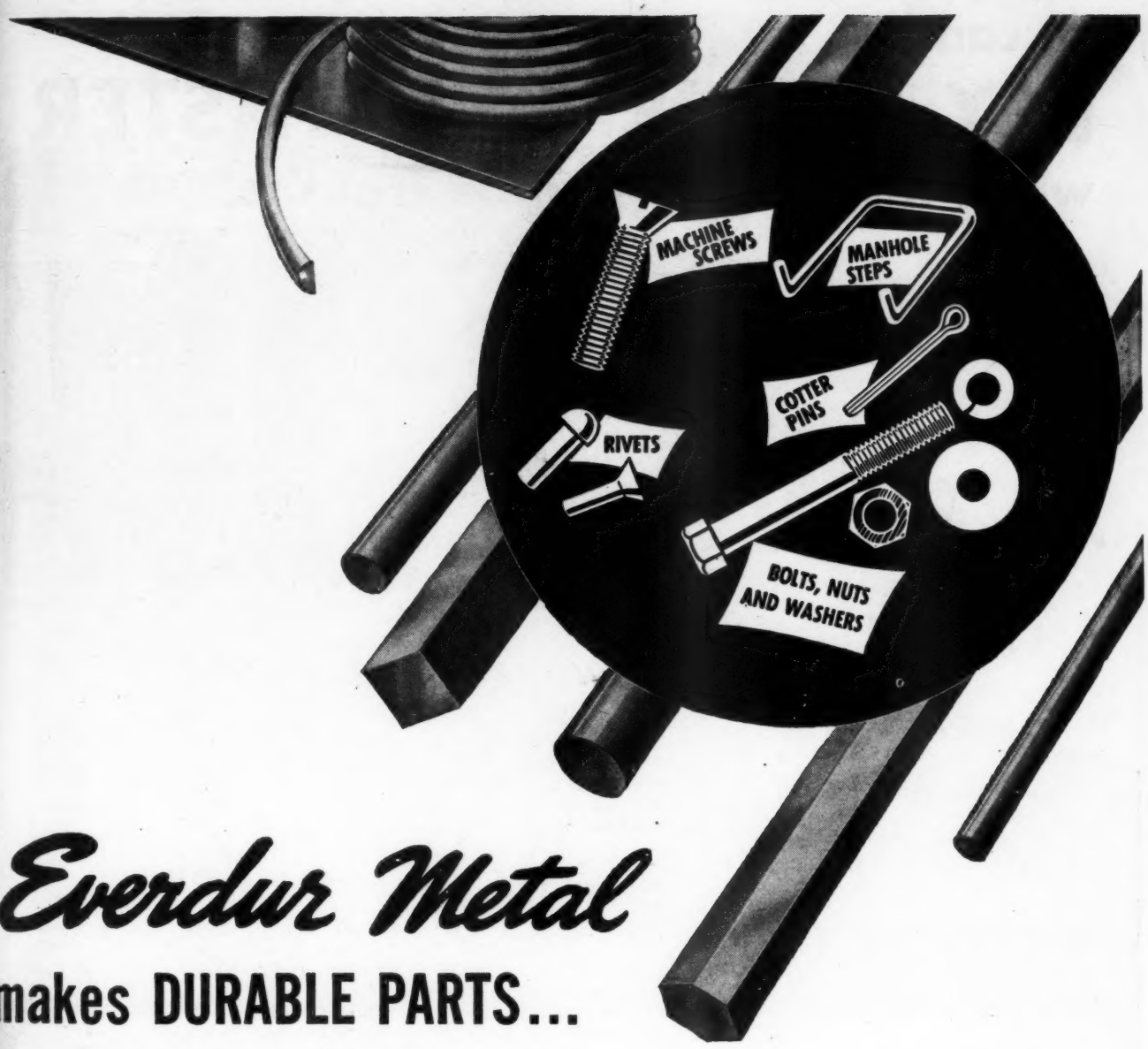

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BECAUSE Everdur* combines high strength and corrosion resistance with ready workability and weldability, these copper-silicon alloys have proven outstandingly durable in hundreds of water works and sewage installations throughout the country.

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For complete information, write for brochure TR-11A. Johns-Manville, Box 290, New York 16, New York.

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Filtering Material Proportioning Equipment
Lime and Soda Hot or Cold Process Softeners—Sludge Blanket Type Reactivators for Softening and Clarifying—
Zeolite Water Softeners—Demineralization Equipment.

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Graver Filters, either vertical or horizontal, are built in all sizes. The filters are furnished complete in all details with the filter media, fittings and controls to meet any operating condition. Graver Water Filters insure a supply of uniformly clear, filtered water to meet the most rigid requirements.

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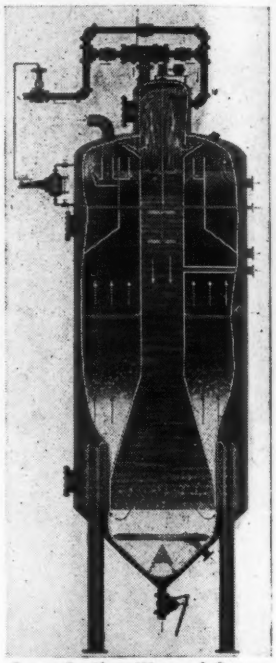
Graver Zeolite Water Softeners can be furnished for manual operation using individual gate valves, or for semi-automatic operation whereby the various cycles are electro-hydraulically controlled by push buttons, or entirely automatic operation, where all of the operating cycles are controlled automatically.

Graver can furnish all types of zeolites: natural "Green Sand" (Gracolo), high capacity "Green Sand" (Gracohi), Gel type synthetic zeolite for sodium regeneration, and resinous zeolite for acid or sodium regeneration.



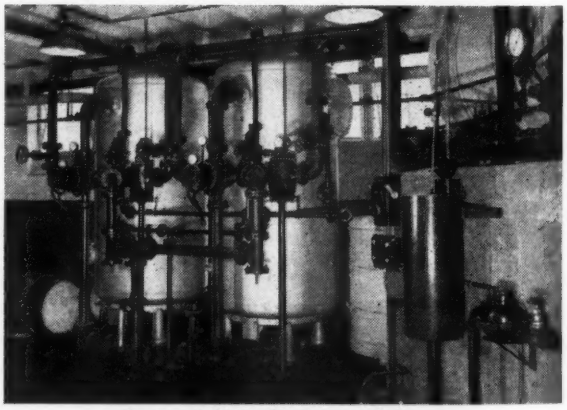
Cross Section View of Graver Hot Process Water Softener With Built-In Deaerating Equipment.

GRAVER SWIMMING POOL EQUIPMENT

Graver equipment for conditioning of swimming pool water meets the most rigid public health requirements. A complete Graver system consists of pressure or gravity filters for the filtering of pool water, coagulant feeders, recirculating pumps, hair strainers, chlorinators, vacuum cleaners, pool fittings, water heaters and pool accessories.

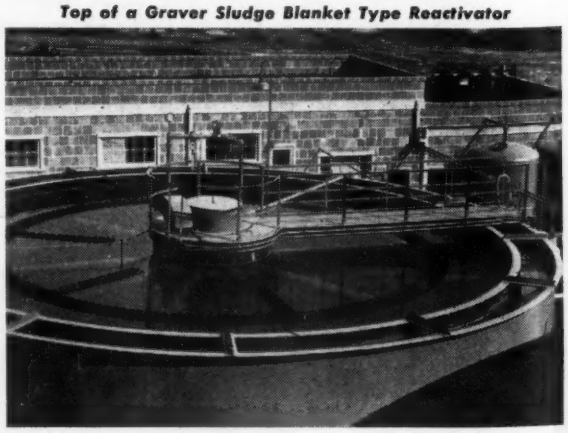
GRAVER HOT PROCESS DEAERATING WATER TREATING SYSTEM

Graver Hot Process Water Softeners remove scale-forming salts and corrosive gases from the boiler water supply rendering the water suitable for use in boiler plants. Supplied as a part of the system are chemical feeders and proportioners, filters and auxiliary chemical feeders for after-treatment. Chemicals are fed and proportioned to suit the flow of incoming raw water and the charge can be varied to meet variations in raw water quality.



Graver Acid Zeolite Water Softener

Top of a Graver Sludge Blanket Type Reactivator



GRAVER REACTIVATOR TYPE WATER SOFTENERS AND CLARIFIERS

This equipment softens and clarifies raw water providing a soft water with low turbidity by means of Upward Sludge Filtration through a suspended sludge blanket. The time required for softening and clarifying is reduced to one-sixth of the time required in conventional types of treating plants. The units can be built entirely of steel or the outer shell can be made of concrete with steel inner chambers and baffles. Chemicals for treatment can be fed from Dry or Wet type Feeders, proportioning the flow of chemicals to water.

ONE METHOD

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OPERATING EFFICIENCY

EFFICIENCY of operation will be even more important in the coming year, when reduced revenue will demand a corresponding reduction in operating costs.

This can be accomplished by a waste water survey.

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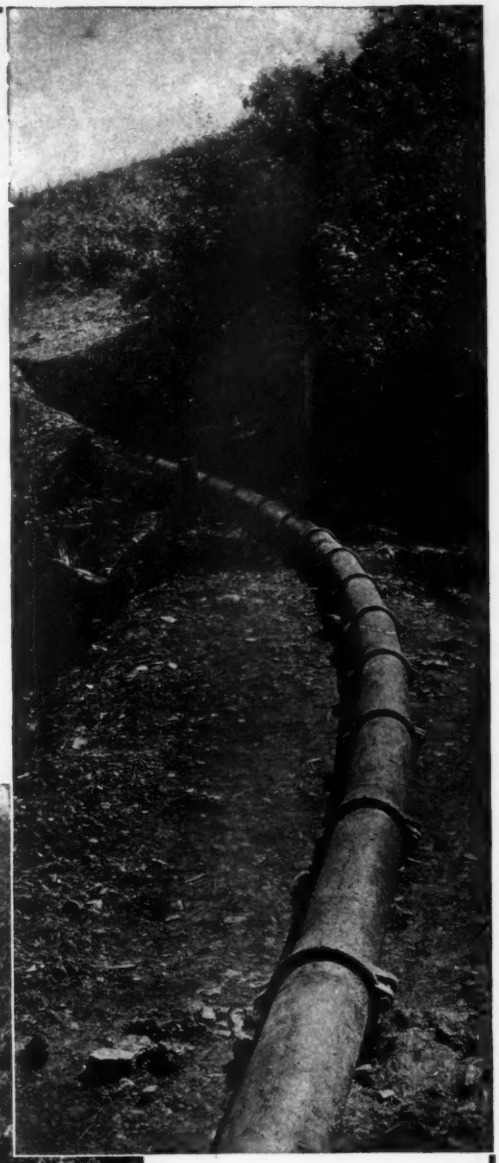

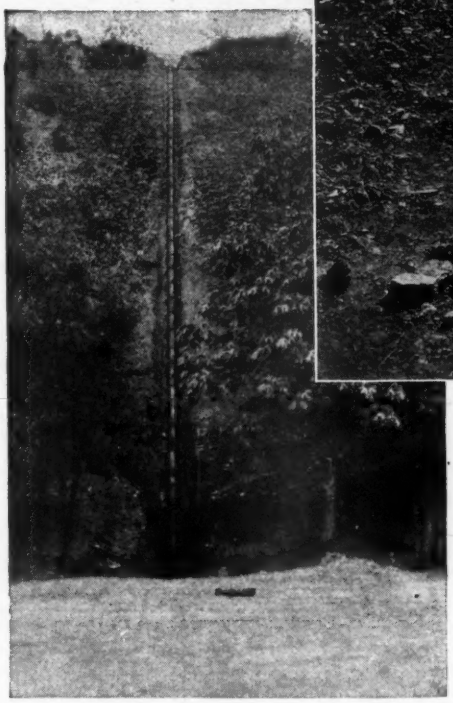

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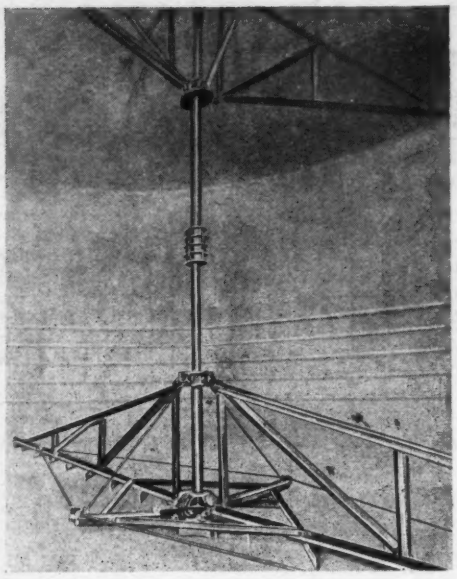

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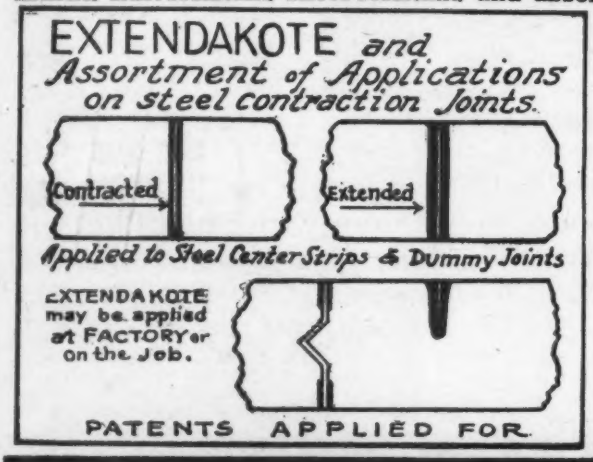
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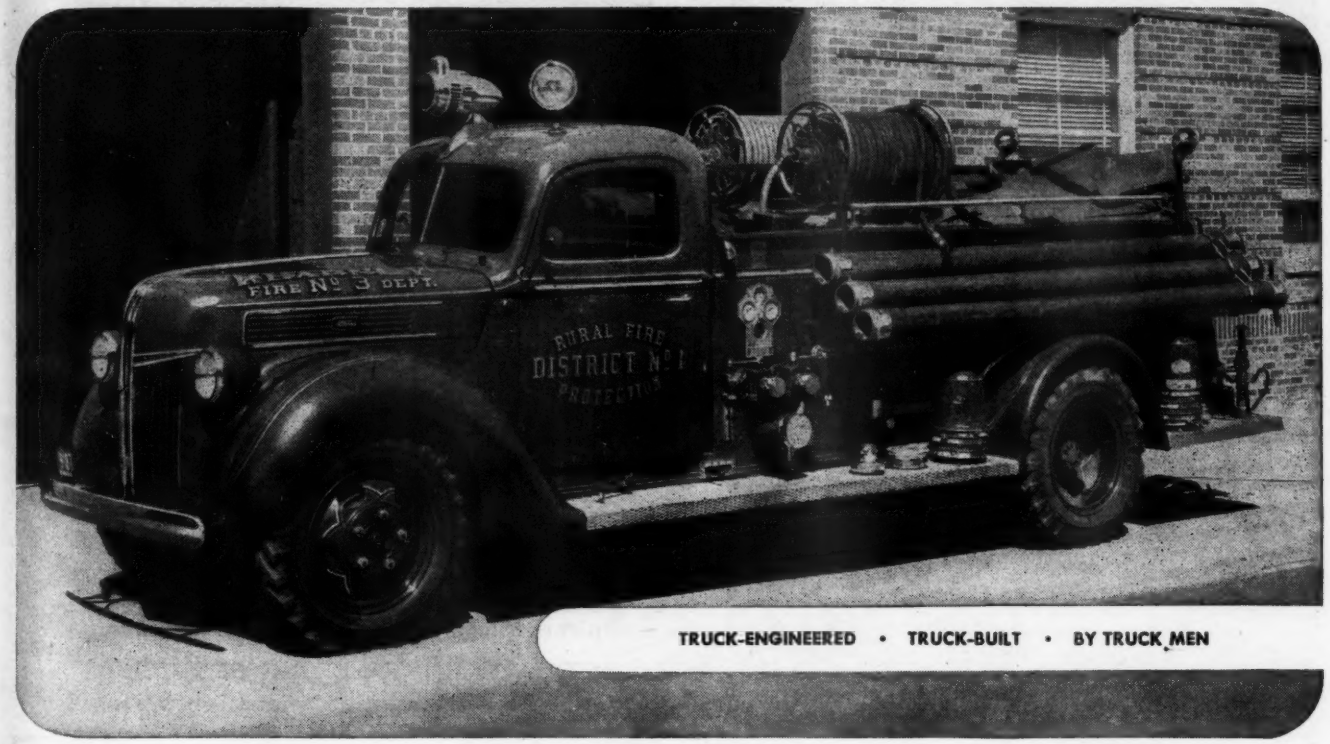

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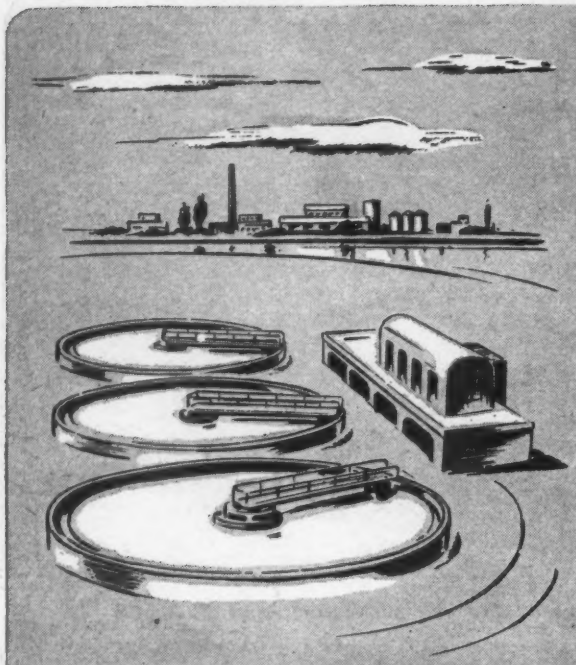

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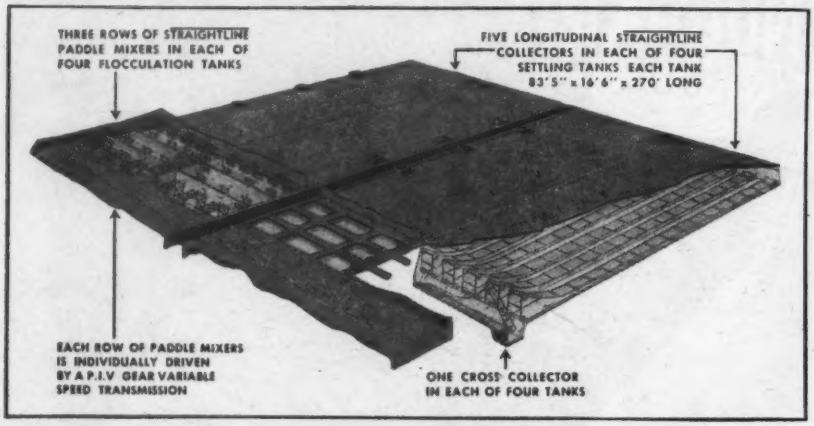
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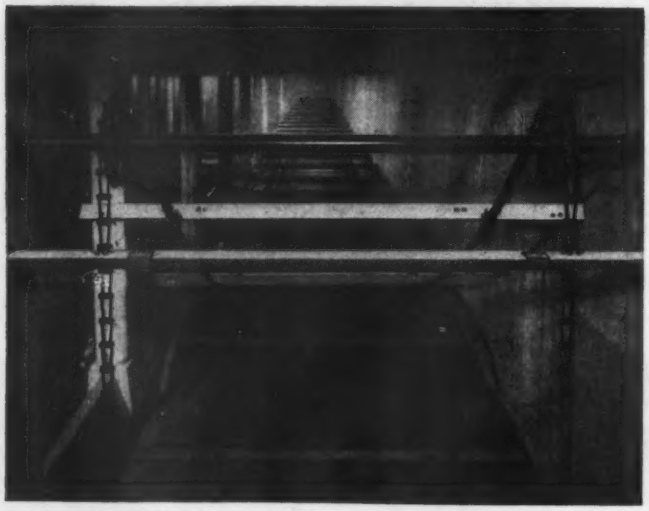

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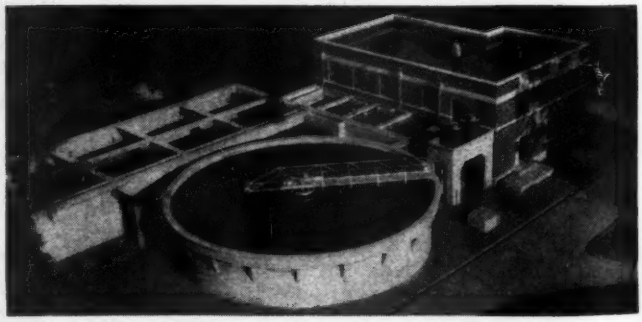

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PUBLIC WORKS MAGAZINE . . . April, 1946

VOL. 77. NO. 4

All photos courtesy War Department Bureau of Public Relations

Loading water into drums at Myitkyina, Burma. In this method of handling water, contamination was highly probable.

Water Supply for the Stilwell Road

Providing a safe water supply under tremendous difficulties; boiling; filtration; chlorination; bacteriological quality; what should have been done. Written by the engineer in charge.

By C. W. CHRISTENSON

DESPITE the fact that there was ample water available, the problem of water supply all along the Stilwell Road, was replete with difficulties. Local customs, untrained medical and line officers, the prevalence of amebic dysentery, the length of the supply line, and the type, training and equipment of the troops in the area, all contributed their share of difficulty. The problem was finally solved, but not until well toward the close of the war.

Troops were scattered from Ledo to Mong Yu, a distance of 467 miles. At least half of the approximately 50,000 troops were in concentrations varying from platoon to company strength. In addition, there were five fairly important subdepots, but these were spread over such areas that, due to the limited amount of pipe available, no single supply could be provided to serve all the troops in any one camp. The QM, Signal and other non-engineer units were not provided with water supply or purification equipment. Consequently there was never nearly enough to meet all the needs. The Road being on the end of the longest supply line in the world, it was possible to get only the most essential equipment. Priorities for water supply equipment were high, but in many cases road-building equipment was more essential. Even when supplies did arrive, they were often in bad condition. This was initially true of high test hypochlorite, the containers of which were of lightweight metal. It was not unusual to find 50% of the cans in a shipment rusted through and the contents spoiled.

The continuous pressure to complete the Road naturally made everything else secondary. Moreover, units were constantly changing location—a camp of one month duration was considered a "permanent station." This made construction of elaborate water supplies unfeasible, except at permanent depots and at General Hospitals. This same impermanency of location, as well as the pressure for speed, resulted in heavy personnel turnover, so that men trained in water supply were often diverted to other work before they had a chance to use their training.

The spectre of amebic dysentery was always at hand. Army water supply equipment, if operated at the rate established by the Corps of Engineers (10 gals. to 12 gals. per min. per sq. ft.) will not remove amebic cysts. Corps of Engineers water supply personnel were not trained in proper methods of operation (despite a good deal of pressure by the Sanitary

Corps.—Ed.). The standard army canvas sedimentation tanks would last only about 6 weeks in the monsoon season, due to mildew and rotting. Out-of-date medical texts panicked medical officers into believing that amebic cysts were everywhere and filtration would not remove them or chlorination kill them. Actually, the small number of natives living in the Patkai Mountains and the Hukawng Valley areas make it difficult to conceive of any great possibility of gross contamination of surface water, though in the Ledo area the streams were undoubtedly somewhat contaminated. As a result of their fears, medical officers ordered boiling of all drinking water.

No sanitary engineers, other than those assigned to malaria control, arrived in the area until May, 1944, at which time two captains, Sn. C., arrived; one was immediately assigned to malaria control and the other as Forward Area Medical Inspector (Ed. Note: This lack of engineers was due to the refusal of the then Theater Surgeon to permit sanitary engineers to be sent to the Theater. After his relief, an ample number of sanitary engineers was assigned to India-Burma.) The writer was placed in charge of the water supplies in April, 1945. He was assisted part or whole time by Capts. R. L. Johnson, R. J. Schliekelman, F. F. Heisel and J. A. Crowley, all Sn. C. (Major G. R. Frith, Sn. C., was the sanitary engineer on the staff of the new Theater Surgeon.)

A letter received in Sept., 1944, from the Surgeon General's Office recommended, as standard treatment procedures in amebic dysentery areas, coagulation and presettling for one hour (followed by filtration at 6 gals. per sq. ft. per min.), and suggested the use of 3 canvas settling tanks. Unfortunately this letter was interpreted literally and Base Sanitary Regulations were changed to require 3 settling tanks, despite the fact that because troop units were small, water use was low, and 2 hours presettling could be obtained with one tank. Water from mobile and portable purification units was boiled before using, sometimes even after chlorination. The Ledo Base Surgeon required that all drinking water be boiled 20 minutes. Later this was reduced to 5 minutes, but a good many folks felt "if 20 minutes is good, 2 hours is better," despite the scarcity of fuel. Also this requirement worked a hardship on those units that had good treatment plants or wells producing safe water.

Pump and well on Burma Road.

Boiling As a Means of Water Purification

While everyone seemed to think boiling was a panacea, and it is true that all pathogenic organisms are killed, so much faith was put in the sterility of boiled water that there was a general laxity in precautions in handling the water after boiling. Most water was chlorinated before boiling; since many officers were under the impression that the chlorine remained in the water during and after boiling, post-chlorination was neglected. Water, after boiling, was usually flat and tasteless and was often warm when placed in Lyster bags. Due to the general unpalatability, and to the cloudy appearance following boiling, the water was not very acceptable to troops, and it is believed that many of them obtained their water from other places.

It must be borne in mind, however, that in many cases boiling was an absolute necessity; there was no equipment available for other treatment at many places. Even late in 1945, some installations because of lack of equipment, had no way of obtaining potable water except by boiling. However, the defects inherent in boiling are indicated by the bacterial results given in the next paragraph.

Bateriological Quality

In November, 1944, a spot check of water quality was made, the Ninth Medical Laboratory collecting about 150 samples. Of these, 80% were not potable or were of questionable potability. At this time, no great emphasis had been laid on post-chlorination. In the following May, after post-chlorination had been required, another check showed 30% non-potable or questionable. In May, also, a water sampling program was established and monthly—in some cases weekly—samples had to be submitted. Results of bacteriological examinations were transmitted to units and non-potable results were followed by command letters outlining correct procedures. Even in October, after 6 months of concentration on water purification and post-chlorination, 15% of all samples from units depending on boiling for purification were non-potable. In contrast, for the same month, only 2.5% of the samples having approved wells or surface treatment plants were non-potable.

Progress in Purification

Beginning in April, 1945, use of water from installations approved by the writer became automatic. The improvements accomplished and the bases of procedure are best explained by grouping these data under headings indicating the various sources and methods of supply:

Deep Wells.—The first project was the completion of, and installation of chlorinators on, the deep wells in the 20th General Hospital area, the 69th General Hospital area and the Ice Plant. Water from these sources was then approved. The well at the Ice Plant contained a great deal of iron which precipitated out after chlorination by holding in a 400-gallon pressure tank (to complete precipitation) and filtration through a mobile purification unit. Following this a total of five deep wells were drilled in the Ledo area, all of which were equipped with chlorinators (some were improvised) and the water was approved for drinking. One well, in the Harmony Church area, pro-

Pipe line bringing water from the Irrawaddy River to water tank and treatment plant along Burma Road.

duced too much sand to be used for drinking water and after all attempts at clearing it up failed the water was used only for showers, etc., and the units obtained water by hauling it from the nearby 69th General Hospital plant. These deep wells were all about 100-150 feet deep and were equipped with 60 GPM deep well turbine pumps. Deep well pumps and drilling equipment were on the way to Myitkyina on V-J day but were never used due to the imminent closing of the base.

Shallow Wells.—Some of the shallow wells in the Ledo area (Ledo Air Base, 382nd Engr. and 24th Ordnance Co.) were improved by a concrete apron around the casing and the installation of hypochlorinators, and were approved as sources of drinking water. Since the water had to be boiled anyway, wells driven prior to April were not ordinarily protected because the Engineers deemed it unnecessary work. These wells had to be renovated. The criteria for approval of shallow wells were: Concrete apron 6 feet in diameter around the casing with 3 inches of casing extending above the concrete; 30 feet deep; and equipped with some satisfactory means of chlorination to give a residual of 2.0 PPM at the well. Chlorinators were improvised, where necessary, by tapping the suction side of the centrifugal pump and installing a ¼-inch line from that point to a tank of hypochlorite solution.

Plans for construction of shallow wells were drawn up, with the aid of Maj. O. E. McGuire, Sn. C., and distributed by the Office of the Surgeon. The 45th Engineer Regiment drove six wells at their camps along the road from mile 100 to mile 167 in the Hukawng valley. These were equipped with meter-operated hypochlorinators and, since the water table was about 10-15 feet, the ordinary 55 GPM pump, a part of the portable purification set, was used. This proved to be a good solution to the problem in those areas where the water table was high enough to permit the use of centrifugal pumps. Three units in the Myitkyina area renovated old wells and after equipping them with hypochlorinators these were approved. These wells had been dug by the Burmans, were about 5 feet in diameter and 40 feet deep and protected by a concrete casing the full depth of the well. Other Engineer units were urged to drive wells wherever possible but since the duration of the campsites was problematical, they were reluctant to do very much work on such projects. One or two units did get wells driven but before they could be approved the units either moved to China or were returned to the ZI.

Semi-portable, knockdown 40-60 GPM purification unit.—This unit consists of: a wooden, circular presettling tank, having a theoretical detention period of one hour, which is equipped with a baffle chamber consisting of over-and-under baffles, providing a ten-minute mixing and flocculation period, a 5-foot diameter rapid sand filter of conventional design; four hypochlorinators; a backwash water tank; two low-lift pumps; two high lift pumps; and one backwash water pump (300 GPM). Included in the equipment are all the necessary instruments for testing and laboratory control. The unit is well designed and operates well but some difficulty was experienced with the air cooled engines operating the pumps and it is felt that the flocculation and setting facilities are a little less than adequate.

These units were installed at the following places: three at the 20th General Hospital, two at the 69th General Hospital, two at the Ledo Ice Plant and parts of three units at the hospital area in Myitkyina. Although ground storage tanks were provided for the plants in the Ledo area they were not designed for flocculation and presedimentation.

The unit at the 69th General Hospital was improved by the addition of a flocculation chamber and reconstruction of the ground storage tanks to permit preflocculation and sedimentation. Constant head boxes were used to feed solutions of chlorine, alum and soda ash to the flocculation chamber. The source of water was a small, extremely dirty stream. The plant was put in operation in May and three different units have since operated the plant, experiencing no great difficulties. To date less than 1% of the samples from this plant have been non-potable. In the summer of 1945 an order was issued requiring units in the Ledo area that were boiling drinking water to obtain their drinking water from this plant.

The plant at the 20th General Hospital had been in operation for some time but since flocculation and sedimentation were poor and the sand in the filters inadequate the water was unfit for drinking. Before the plant could be improved the wells in the area were completed and could supply all of the water needed so the plant was later used for providing water for the swimming pool.

The plant in the Myitkyina area was designed according to sound practice and included settling and flocculation, but due to the lack of suitable supervision and to constant changing of operators, as well as difficulty with the mechanical equipment, the plant was not put in use before the hospitals were inactivated. Capt. Johnson and Capt. Schliekelman were transferred before operators could be trained adequately and then Lt. Schwicker, C. E. was assigned to the plant but he, having sufficient points, was returned to the ZI in October.

Mobile purification unit.—This unit consists of one 60-75 GPM high lift pump and a 42-inch pressure filter and is equipped with alum and soda ash solution pots and a gas chlorinator. Unfortunately no chlorine gas was available and the units had to be equipped with a hypochlorinator that was run off the shaft of the pump engine. The design rate is 60-75 GPM depending on the size of the pump (this is five times the approved filtration rate.)

Plans were drawn to operate these units in a manner that would produce potable drinking water. This called for a two-hour detention period in a tank equipped with some means of flocculation. It was planned to feed the chemicals to the tanks either by means of hypochlorinators or constant head boxes. These plans were however, turned down by the engineers on the basis of requiring too much labor and equipment that was needed for hospitals. For this reason only one mobile purification unit was set up in the approved manner. This was at the Myitkyina subdepot. It was equipped with an adequate concrete flocculation and sedimentation basin and constant head boxes for chemical feed.

Portable purification unit.—This unit consists of an 18-inch pressure filter, pump, hypochlorinator, alum and soda ash solution pots, and one or two 3000-gallon canvas storage tanks. The filter is entirely inadequate and the alum and soda ash solution pots are difficult to control at rates less than 30 GPM.

Plans were drawn for the operation of these units and criteria for approval were essentially the same as those set up by the Office of the Surgeon General, i.e., filtration rate not to exceed ten gallons per minute, preflocculation and sedimentation and pre-chlorination sufficient to maintain a residual of 2.0 PPM after filtration. By this time a limited supply of rubber petroleum storage cells (3000 gallons) were available for storage tanks and these were supplemented by 1000-gallon tanks constructed from six-foot culvert sections. Where water consumption was less than 3000 gallons per day only one tank was needed. It would be filled in the evening (while filling, alum, soda ash and chlorine were added), allowed to settle over night and post-chlorinated and filtered in the morning. The 778 EPD Co., three companies of the 1304 Engr. Bn., one company of the 1905 Engr. Bn., the 823 Engr. Bn. and the 1877 Engr. Bn. had such units in operation. Some other Engineer units had drawn plans for constructing plants according to these regulations set up. However, before they could be completed the units moved either to China or the ZI.

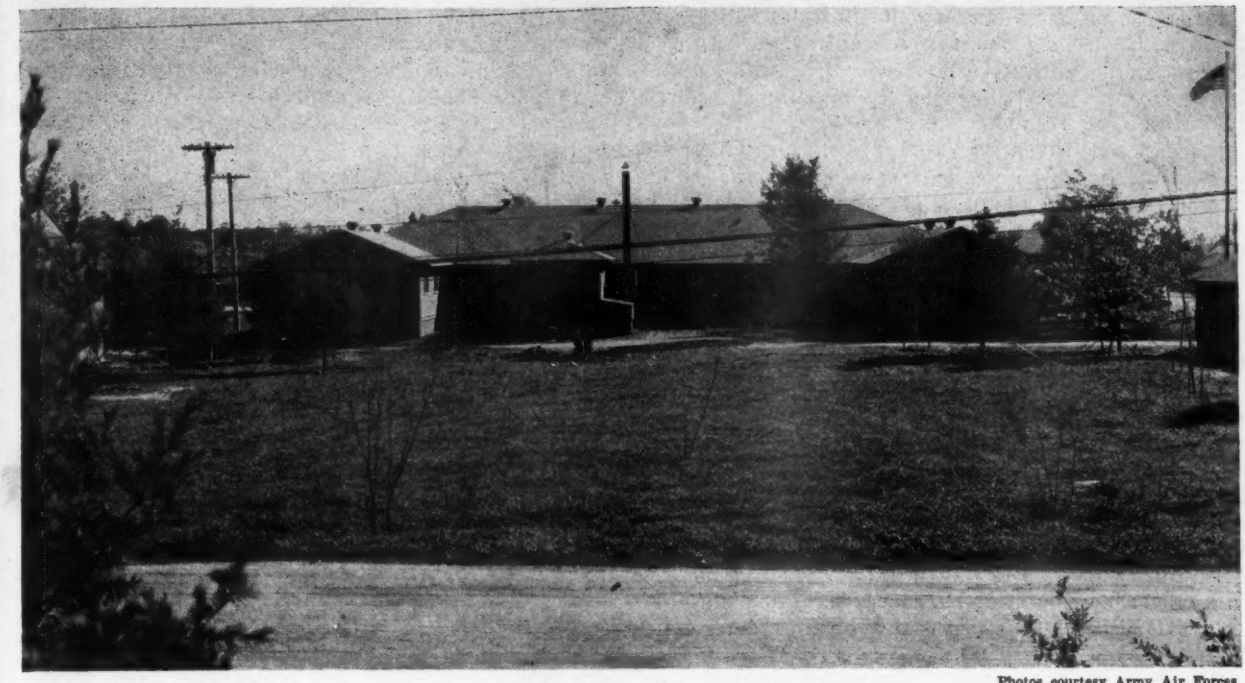
Super and dechlorination.—During 1944 and 1945 several units were urged to use superchlorination and dechlorination as a means of water purification—all to no avail. The reasons for not using it were either lack of confidence in the method or lack of confidence in personnel doing the work. In August, a letter was received from the Office of the Surgeon General which contained a suggested method of water purification using superchlorination. This method was tried out in the Ledo Staging area and very good results were obtained for a while but an unexpected large influx of troops to this area so overtaxed the facilities of the plant that the method had to be abandoned. At this plant the chlorine was admitted, at a rate of 20 PPM, to a small storage tank, equipped with a baffle to prevent short-circuiting, which provided a detention period of one hour. From the storage tank the water was pumped through two hypochlorinators (these fed a solution of sodium thiosulfate), and then through two mobile filters. Because HTH was not available it was necessary to use grade C hypochlorite which was fed to the tank by means of two constant head boxes. Some difficulty was encountered here because of the strong solution of chlorine necessary which could be obtained only by the addition of soda ash which formed sodium hypochlorite which fed through the constant head boxes with little difficulty. This had one advantage in that no other chemical feeder was necessary for soda ash. In the limited time of operation it was found that good control of chlorine dosage could be obtained by use of the constant head boxes and that the hypochlorinators feeding sodium thiosulfate were quite capable of maintaining a final chlorine residual within very reasonable limits. This method has a great deal of merit and warrants much wider application.

General.—Reluctance to improve water plants was met with on every hand. When presented with plans for improvement in many cases the answer was, "We've been boiling water for six months (or a year or two years) and have had no serious outbreaks, why change?" or "This country is so damn filthy and full of diseases that I wouldn't trust any method other than boiling. It's the only way you can kill amebic cysts isn't it?" The transient nature of the camps made troops reluctant to build a plant that they would have to abandon in a short time. Then of course, after V-J day the main thought in everyone's mind was not about water supply but "When am I going home?"

What Should Have Been Done

Of course, "Hindsight is easier than foresight" and the tactical situation dictated, in the final analysis, what had to be done. The following statements are made knowing that their attainment was sometimes impossible, yet had they been carried out, the water supply would have been much improved.

(Concluded on page 49)



Photos courtesy Army Air Forces

The scene below after grading and planting.

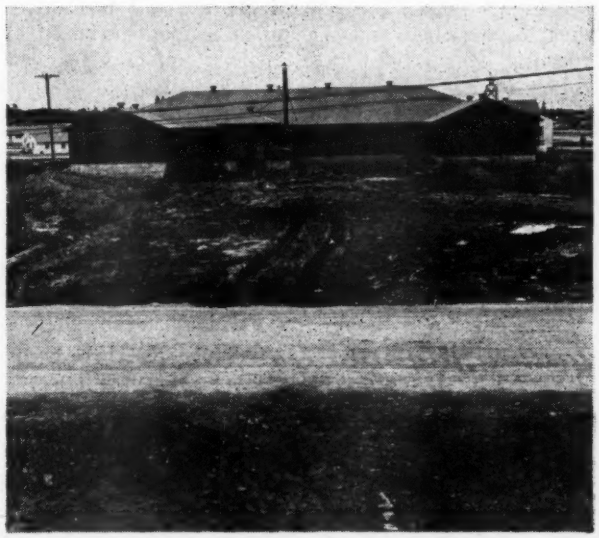
Grounds Maintenance and Vegetation for Airports Highways and Park Areas

VEGETATION, where it can be grown, is the most economical and effective agent for ground covering, stabilization and maintenance of unpaved airport areas, roadsides, parks, athletic fields, playgrounds and areas around public buildings. It is also the most attractive. To provide and maintain a satisfactory grass cover under severe conditions of wear may be difficult. Proper soil preparation, selection of suitable grasses and well-planned and constant care are essentials for good growth.

Engineers are frequently charged with such maintenance, but few of them are trained in agronomy. In the case of a large city, with extensive grass areas to maintain, the services of an agronomist as a staff member for advising all city departments is a good investment. The smaller cities and villages should utilize local men with training in this field, or they can obtain advice from agricultural agents. In nearly every case, such advice in regard to grasses is as necessary as is engineering advice for bridge or airport design, and saves both time and money. The Park Departments of some cities have agronomists who are available for advice to other municipal or county services.

Many engineers have had the experience of being called in on a job too late, after the project has progressed to a point where either a good engineering job is no longer possible, or the cost of doing one is excessive. Like the engineer, the agronomist should be available for advice on a construction job from the beginning. In the case of an airport, especially, timely advice is essential for a good job; and the same is true of a highway project involving large cuts or fills, and of many other types of work. In such projects, it is essential to install all utilities, complete construction and do all sloping and leveling before seeding. So far as can be arranged, the best soil should be left on the surface. What grass or other vegetation is suitable for a given locality depends upon the geographical location, the type of soil, rainfall, and the use that will be made of the installation. Therefore, no specific recommendation can be made in this respect. The advice of skilled men with local experience is essential.

The equipment needed depends on the size of the areas to be maintained. The following is recommended for use where extensive areas of grass must be main-



This is the area shown above before improvement.

tained: A rubber-tired tractor, the size depending on local conditions; a plow, a spike-tooth harrow, a disk harrow and a cultipacker, all with tractor hitch; a lime distributor and fertilizer or manure spreader, also with tractor hitch; a corrugated or perforated roller; a power-driven lawn mower; a high-speed gang mower; a rake with tractor hitch; a small truck, about ½-ton; hand tools; and seeding equipment. For smaller areas, some of this equipment can be dispensed with or rented when needed.

Soil preparation is highly important. In general, the exact details of procedure will depend upon local soil and climatic conditions. Soil tests and analyses are the first step. If no local source of information is available, write the State Agricultural College or Experiment Station and arrange for analyses. Generally, advice given by them will include the type and formula of fertilizer needed. The ground should be fertilized before plowing, and preparation of the soil two or more weeks before seeding is desirable. Poor soils may require a soil-improving crop, such as soy beans, lespedeza or cowpeas for spring planting, or vetch, crimson or bur clover for fall planting. A well-fertilized soil is essential to obtain a dense sod that will stand up under usage.

The amount and seasonal timing of rainfall are important elements that cannot be controlled. Where rainfall is deficient or there are long periods without it, consideration should be given to irrigation or to organic mulches to retain soil moisture. An irrigation scheme may be possible that will add to the success of the growth without excessive cost. Fertilization will be necessary; while nitrogen is the most important element affecting the rate and vigor of growth, the other essential fertilizing elements should not be neglected.

The seeded soil should be protected where conditions are unfavorable, as where the soil is poor, and on slopes and eroded areas. A light mulch of straw, hay or manure, about 1 or 2 tons per acre, which should be applied immediately after seeding, is helpful in preventing the washing away of the seed and in retaining moisture in the soil.

The use of organic mulches of straw, hay, low-grade grass or manure tends to prevent water erosion, retain moisture and reduce dust blowing. They are applied at any season of the year at the rate of 1 to 3 tons per acre. For dust control, the heavier application is better. On open areas subject to strong winds, the mulch must be anchored. If the soil is hard, it must be loosened and the mulch is then anchored by running over it with a sheepsfoot roller, a Dunham rotary hoe set in reverse, or a large disk set straight. When the mulch has been properly applied, the area should look like a stubble field. Mulching may cost $50 or $60 per acre, but it may be essential in establishing a good cover in a difficult place. Quick-growing crops may be used in place of mulches under many conditions.

Proper mowing is important in maintaining good grass cover. The primary objective of mowing, where a grass cover must be maintained, is not beautification. Proper mowing increases the density and vigor of the grass and develops a tough sod. Grass should not be cut close under the conditions covered by this article; ordinarily 3 to 4 inches of top growth is necessary, and more is desirable in dry areas.

Newly seeded or sodded areas and new grass should be protected by restricting traffic over them. After each rain, the areas should be inspected, and eroded areas and gullies should be repaired, and new sod planted where necessary. It may be desirable to build check dams, or to pave channels carrying runoff water, for which paving sod may be used where the velocity is low. Sod need not be cut too thick—1½ to 2 inches is enough—but the soil must be prepared for it as carefully as for seeding.

Grass cannot usually be maintained on airplane parking or maintenance areas, and on these other types of surface covering are necessary. On grassed landing fields, landing areas should be rotated and a heavy stubble should be left by the mower. Uniform mowing of the field tends to encourage rotation of use of various areas. There are very definite limits of weight and traffic intensity, beyond which grass cannot be maintained. When these limits are reached, other means of soil protection must be adopted, such as oiling or the use of calcium chloride for dust prevention; or a surface treatment or other pavement. The choice between these methods will depend on the intensity and weight of traffic.

Earth Wearing Surface Does Not Impair Durability of Treated Wood Bridge Floor

Wearing surfaces on treated wood bridge floors are desirable because any appreciable daily volume of highway travel has an abrasive effect on the floor members if they come in direct contact with the wheels of the passing vehicles, and this abrasion tends to impair the preservative treatment. In general, it is the practice of most engineers to use the same type of wearing surface on the bridge as exists on the adjoining highway, since such uniformity contributes to smooth riding. This is particularly true on lower types of rural roads which have earth, sand-clay or gravel surfaces, and which must be given blade maintenance at regular intervals. In such cases, if the bridge surface can be maintained with the rest of the road, bumps and impact at bridge ends can be eliminated.

It is well known that ordinary untreated floors may decay rapidly under earth, sand-clay or gravel surfacing, and a question is sometimes raised as to whether the practice of laying such surfacing directily over a treated wood bridge floor will be detrimental to it also. The answer to that question is, according to *Wood Preserving News:* If the floor plank are properly pressure treated with creosote and if they are not so mishandled during placement as to nullify that protection, the treated floor will last as long as any other part of the bridge.

Capacity of Mowing Equipment

In a paper before the American Road Builders' Assn., E. C. Todd and O. H. Hays, Corps of Engineers, gave the following approximate capacities of several types of mowing equipment:

Farm or highway tractor and sickle, 7 ft. mower bar—3½ acres per hour.

Golf course tractor, 7-gang mower—11 acres per hour.

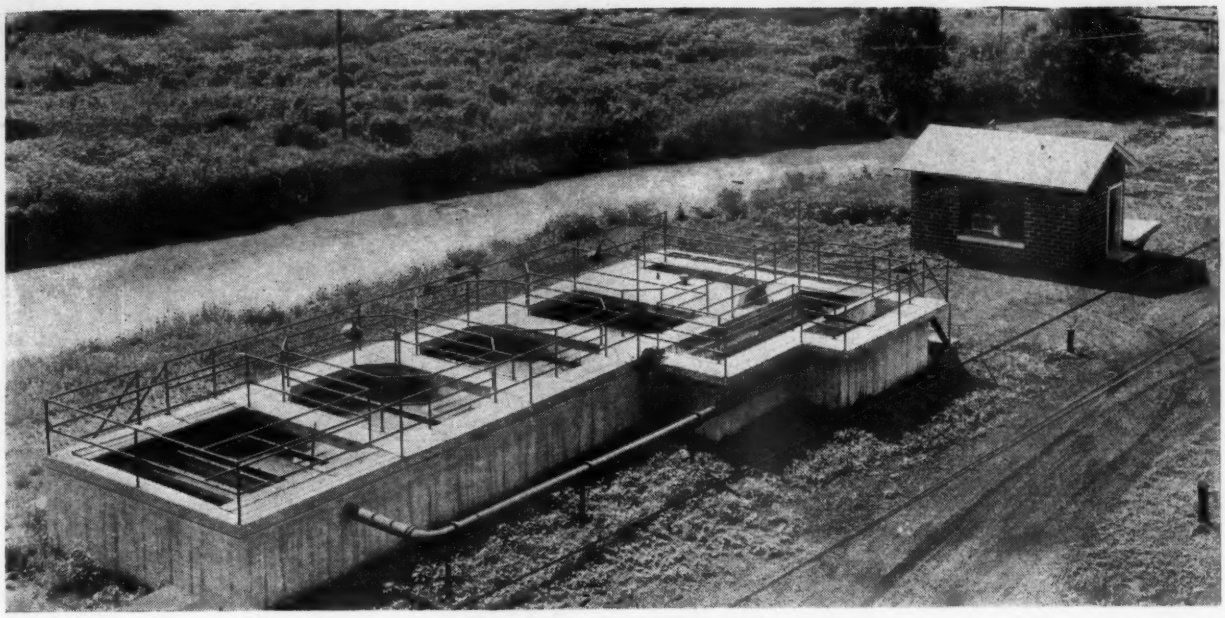
Airfield tractor, 9-gang mower—46 acres per hour.

Power mower, 30 to 32 inch—4 to 5 acres per 8-hour day.

Power mower, 25 to 26 inch—2 to 3 acres per 8-hour day.

Power mower, 22 inch—1½ to 2 acres per 8-hour day.

Hand mower, 18 inch—1 to 1¼ acres per 8-hour day.



Link-Belt paper waste treatment plant; pulp is recovered.

Industrial Waste Problems and Treatment

A resume of the developments in industrial waste production and treatment as reflected in three years of engineering literature, with a bibliography.

THE war brought on new problems in industrial wastes, primarily because of the accelerated manufacturing program necessary for the prosecution of the war. New types of wastes were produced, notably those resulting from making synthetic rubber. Because of the shortage of critical materials, and probably for other reasons also, relatively few treatment plants for industrial waste were built, but the pressure for better treatment of both sewage and industrial wastes has been building up for a number of years. Coincident with this have been the developments in sewage treatment knowledge and processes, so that it is now possible for a community or an industry, except in unusual cases, to afford adequate treatment.

Charges for Treating Wastes.—Besselievre[1] recommends that charges be based on suspended solids and BOD, including a fair proportion of both fixed and operating costs. The charge may be based on the excess of these units over and above the normal content of domestic sewage; or it may be based on their gross amount. There is some support for the belief that taxes paid by the industry to the municipality should be credited against the charges for treatment. In any case the wastes discharged should be equalized and should not impose an undue burden on the plant.

In Celina, O.,[2] cannery, milk powder and stearic acid wastes are discharged into the sewers. These wastes represented, on a population equivalent basis, 135% of the domestic sewage strength in 1943 and 200% in 1942. Lump sum charges are $2000 for the cannery, $350 for the creamery and $50 for the acid plant. The cost of BOD removal in 1943 was $9 per 1000 pounds and in 1942, $7.30, and it is believed by this community that the lump sum charges given above are fair and reasonable.

Buffalo, N. Y.,[3] employs a formula for charging for treatment of industrial wastes when these have a suspended solids content or chlorine demand 3 times or more as great as the average sewage. This formula is based on the price of chlorine; the chlorine demand of the waste is ppm, in excess of the normal sewage chlorine demand; the cost of chemicals for sludge conditioning and the cost for power for disposing of the solids; and the differential between the suspended solids in the waste and in normal sewage at the plant. Charges are also made for cleaning sewers when clogging is directly attributable to the discharge of industrial wastes.

Industrial wastes should be discharged into sewers but the industries should pay for the excess loading that such wastes cause, not only in the sewage collecting system but also at the treatment plant.[4] This excess loading is defined as that over and above the normal loading caused by domestic sewage.

Effects on Fish Life.—A classification has been proposed[5] of industrial wastes affecting fish life to include: 1. Suspensoids, which cover the stream bottom and destroy, directly or indirectly, the food on which the fish must live; 2. Materials having an oxygen demand or oxygen consuming power (but not referring specifically to BOD); 3. Compounds altering the pH of the water, for fish do not thrive in water whose pH is above 8.4 or below 6.5, while 5.0 or lower or 9.0 or higher may be lethal; 4. Materials increasing or changing the salinity of the water, for most fresh-water inhabitants react unfavorably to sudden

changes in osmotic pressure; 5. Toxic substances, which may destroy the fish or their food.

Legal.—The city of Kenosha, Wis., was upheld in state court for refusal to accept wastes from manufacturers of brass and copper products after experience demonstrated these wastes materially interfered with operation of the sewage treatment plant.[35]

Laundry Wastes

While laundry wastes do not generally affect the operation of larger sewage treatment plants,[6] they may interfere seriously with chemical and biological processes in smaller plants (under 5 mgd.). The waste may comprise only 5% to 10% of the total flow, but may markedly exceed this concentration for short periods. In selecting the most satisfactory method of treatment, the following data are needed: 1. Hourly sewage flow, average, dry weather and wet weather; 2. BOD capacity of the plant and of the various units; 3. Laundry waste flows in respect to quantity, rates and fluctuations daily and hourly; 4. BOD of the waste and of its fractions; 5. Chemicals locally available for treatment, as lime, acid or other industrial wastes; 6. Equipment, type of personnel and facilities available at laundry and at plant. (Ed. Note: pH and its effect also should be studied.) The above data permit calculations relating to equalizing the flow; holding and discharging at low-load periods; or training chemically all or a part of the waste.

When separate treatment of the wastes is desirable, which may be the case when their relative volume is large,[7] chemical precipitation is more commonly used. The solids usually settle, but may float. Stimulation of flotation and removal by skimming may be desirable. Experiments with vacuum flotation, using ferric chloride or alum, gave good results. Alum was cheaper and required less pH adjustment.

Distilling Wastes

Distillery slop—the residue from the distillation of fermented molasses—could not be effectively treated by certain standard biological methods, nor by electrodialysis, without dilution. Electrodialysis alone results in an overall chemical oxygen demand reduction of about 55%. In the cathode compartment it effects coagulation of the colloidal material, and makes the slop more amenable to chemical coagulation, thus saving chemical. It does not reduce the OC of the soluble organic matter more than 7 to 10%. Followed by 8 hrs. aeration, a reduction of 90 to 93% in OC of the slop was effected, giving a stable residual soluble organic material. It is not economical to continue dialysis treatment beyond coagulation. Treatment of industrial wastes by electrodialysis is most effective when large quantities of colloidal and small amounts of soluble organic materials are present.[8]

In California, investigations have shown[9] that waste from brandy and molasses distilleries has a BOD equivalent of 130 persons per ton of grapes. The land method of disposal used by most distilleries in that area creates serious odor problems. Addition of lime and calcium chloride to precipitate the tartrates, and then more lime to remove other solids, produces an effluent that can be treated on a trickling filter. At the prices then in effect, recovery of tartrates would cover the cost of treatment. Wastes from grain distilleries may be evaporated to produce an excellent live-stock food.

Pickling, Plating and Finishing Liquors

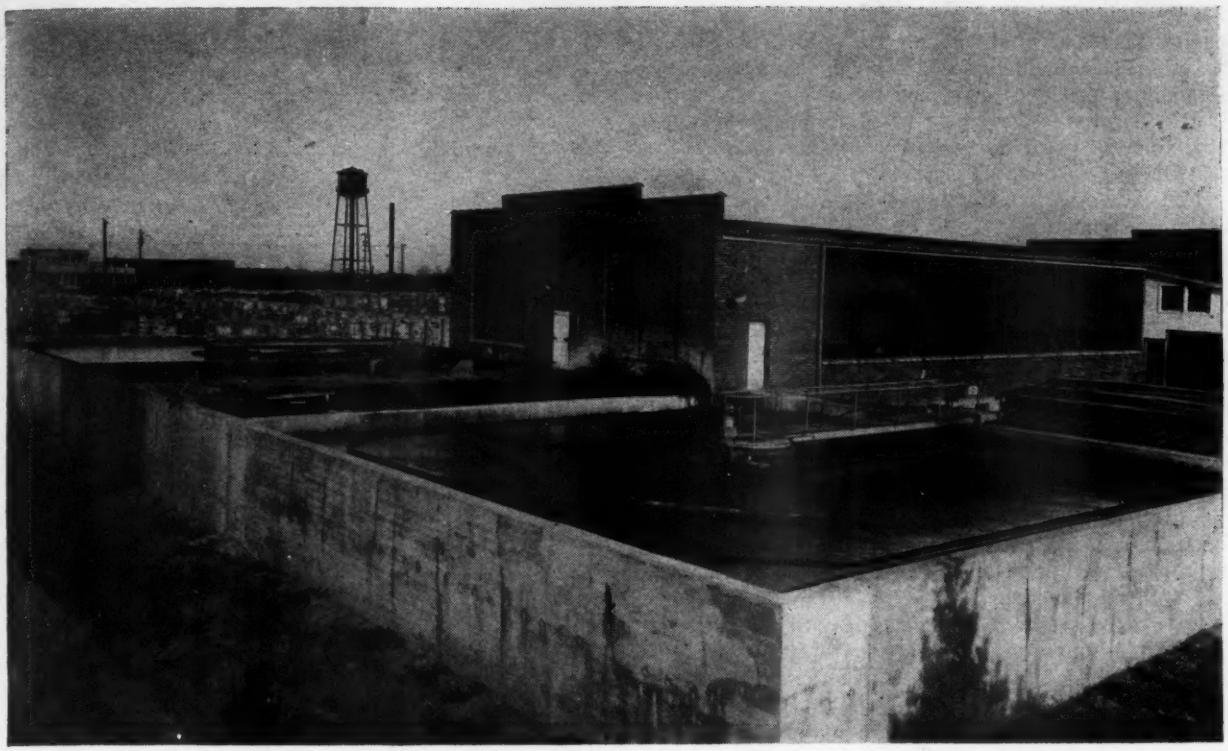
Highly concentrated cyanide wastes from metal finishing in an aircraft factory were treated by chemical precipitation to remove toxic constituents other than cyanides; the effluent was chlorinated and held 20 to 30 minutes during which time the cyanide reacted with the chlorine to form cyanogen chloride which hydrolyzes the ammonium carbonate, which converts quickly to free ammonia and carbon dioxide.[10]

Polysulfide-treated cyanide for case hardening, copper plating and zinc plating did not affect the operation of an activated sludge plant until 1000 ppm. of polysulfide was added.[11] When larger amounts were added, recovery was very quick. These same wastes did not materially affect sludge digestion[13] even when the sewage carried as much as 30,000 ppm of zinc plating solution or 10,000 ppm. of copper plating solution. All wastes increased the H_2S content of the digester gas.

The waste from a small arms ammunition plant contained 971 ppm total solids, 231 BOD, 8.0 copper, and 5.2 zinc; pH varied from 1.7 to 9.5.[12] Lime precipitation, 1 hour storing, mixing and flocculation, and final settling gave a fairly constant pH, removed 60% of the grease, reduced suspended solids from 469 to 32, and permitted lagooning without nuisance.

Sulphuric, hydrochloric, nitric, phosphoric and hydrofluoric acids, sulphuric principally, are used in pickling steel. Treatment is difficult and realization of profit from the treatment not promising.[13]

Metallurgical waste treatment was investigated by



the Chemical Engineering Department of Yale and by the Hall Laboratory of Chemistry at Wesleyan University.[34] The reports, which are too long to abstract here, cover specifically chromium compounds and steel mill and brass mill wastes.

Cannery and Vegetable Wastes

Freezing of cannery wastes in broad, shallow lagoons results in throwing solids out of solution and suspension, and these settle rapidly, and only a small fraction of them go back into solution.[13] BOD has been reduced from 2000 ppm to 500 or even lower. Use of sodium nitrate [14] [15] in connection with lagoons has been promising. Enough is added to supply the oxygen needed to satisfy about 20% of the BOD. By controlling the oxygen sag curve, odors are almost eliminated. Other essential points in treatment by lagoons are also covered. Treatment with vacuum flotation at 2 plants has also been promising.[16] At Celina, O., cannery wastes have been successfully treated in the city plant.[2] At Cokato, Minn.,[12] where corn wastes predominate, a 20 mg. lagoon stores the 16 mg. of wastes produced during the season. From the lagoon, the settled waste is passed through an aerofilter, thence back to the lagoon and to the village sewage plant. Initially there was considerable odor in the filter; this was housed and provided with forced ventilation. Cost of operation is about 0.8 cents per case. In California,[18] screening (¼" holes for primary treatment and 1/16" for secondary) and re-use of cooling water, reducing the volume 50%, were employed. Lagooning has been used at Fairmont, Minn.,[35] after it was found that the local sewage treatment plant was totally unable to handle the wastes from local canneries.

In citrus canning, nearly 60% of the weight of the fruit is waste, the volume of water used is large, and acidity and BOD high.[19] Screening and disposal on sand beds may be used, the solids remaining on the surface being raked off and burned. At Lakeland,

Illustrations: Above, on this page—Dorr clarifiers and flocculator at a paper waste treatment plant. On page 26—extreme left, a Link-Belt glue waste recovery system; and a Link-Belt liquid vibrating screen handling wash water from a packing plant. At the right, this Dorr plant handles 1.3 mgd. from a potato starch factory; 2400 ppm. BOD. Includes screening, heating, 3-stage biofiltration, flocculation and digestion.

Fla.,[20] screening, primary sedimentation, a high-capacity filter and final settling are used. The BOD of the plant effluent increases during the cannery season. Lagooning produces odor and fly nuisance; sand filtration is satisfactory where suitable sand deposits are available. Disposal into lakes or streams usually kills the fish.

Cherry wastes affected the sewage treatment plant at North East, Pa.[37] BOD ranged from 700 to 2100 ppm., and waste volume was 600 to 1800 gals. per ton of cherries. A vibrating screen, chemical treatment with lime and copperas, mechanical mixing and settling for 2 hours effected a 60% reduction in BOD and 88% reduction in suspended solids.

Digestion of pure vegetables has been studied at Cornell University,[21] using cabbage, carrots and potatoes. All digested satisfactorily. Gas contained more CO_2 and less methane than from sewage sludge. Digestion of cabbage created strong odors, controllable by adding activated carbon or orthodichlorbenzene. Wastes from potato dehydration[22] contained 18,000 ppm suspended solids, of which 30% can be removed by a 60-mesh screen; while 80% of the settleable solids can be removed by screening and 90% by settling 10 minutes. A shaking or vibrating screen is used. Sand beds are satisfactory for final disposal. In processing, 20% of the initial weight goes into the waste. Pea canning wastes do not appear to yield to coagulation.[23] Potato dehydration wastes, constituting one-fourth the flow entering the Grafton, N. D., sewage treatment plant,[33] upset operation, increasing effluent BOD to 400 ppm. Wastes were prohibited from the sewers and the industry moved elsewhere.

Oil Wastes

The petroleum industry produces many kinds of wastes,[10] such as brines, unemulsified oil and water mixtures, emulsions of oil and water, elements causing taste and odor in water supplies, wastes having an oxygen demand, toxic or poisonous wastes, alkaline wastes and coloring wastes. The industry is studying the various possible methods of treatment, including dilution by controlled discharge, breaking of emulsions, taste and odor removal, etc. But other kinds of oils, as cutting oils, oil wastes from garages, shipyards, ships, and gas plants also cause trouble.[24] At New Britain, Conn., in 1942, more than 400 cu. ft. of heavy oils per day were removed at the sewage plant. Manufacturers, when approached, generally arranged to discontinue the discharge of oil wastes. At Lancaster, Pa., as much as 1768 ppm. of total grease was removed at the sewage treatment plant; appreciable quantities passed through and interfered with operation. The time required to dry sludge increased 50%. Petroleum oils and greases caused heavy scum formations at the Springfield, Mass., sewage treatment plant.[25] Prevention of entrance of oil wastes to sewers helped. Operation of the digesters, in which principal trouble occurred, was modified to use one digester for tank skimmings only, which largely eliminated the trouble.

In California,[18] oil field waste is generally handled by ponding for evaporation, injection into subsurface sand formations, disposal to waste alkali or sand areas, to salt marshes or the ocean, or discharge into sewers. Settling ponds are used for oilfield waste water. In Illinois[26] more than 3 mgd of brine from oil fields is being returned to underground salt water bearing formations.

Pulp and Paper Wastes

Waste water from paper mills was treated by storage in lagoons for 10 to 15 days.[4] BOD was reduced as much as 90%, and much of the clarified water could be reused. In some cases fiber could be recovered and used in low-grade paper. Digestion of sulfite prepared paper pulp, alone and mixed with fresh raw sewage sludge, was tried at Cornell.[9] Both digested satisfactorily, when added to well seeded sludge in heated digestion tanks. Lime had to be added to maintain proper pH. The amount of gas produced per pound of pulp was less than half that produced per pound of sewage sludge.

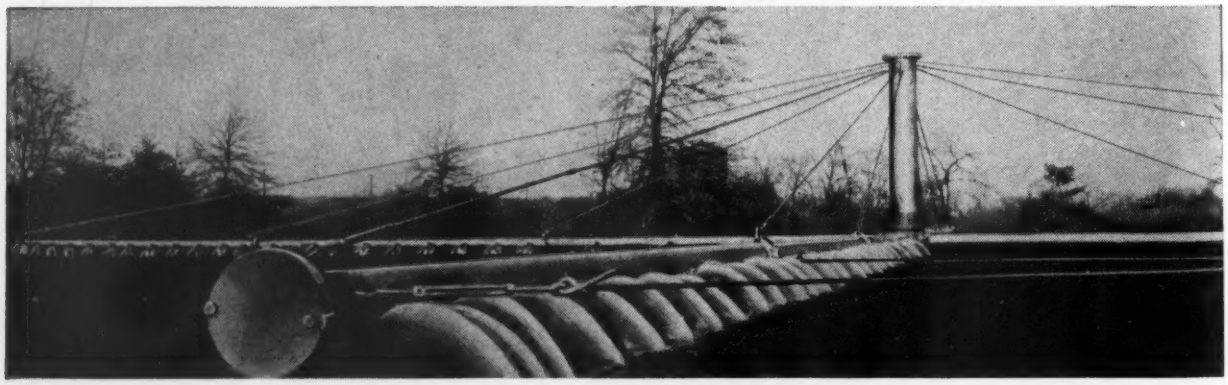
Recovery of pulp from white water was accomplished at a plant at Modena, Pa., using a 16′ x 60′ tank, with a mechanical collector, a revolving scum trough and a horizontal slow mixer.[30] With a detention period of 220 minutes, 90% of the solids are recovered, and pollution of the West Branch of Brandywine Creek materially reduced. This mill produces sulphite paper.

Other Types of Wastes

Packinghouse wastes vary per animal killed, from 1 to 4 gallons per pound.[20] The composition of wastes also varies, containing much grease, and a high BOD and suspended solids content; and the temperature may reach 90°.

Tobin Packing Co., Ft. Dodge, Ia., installed a grease recovery system in 1942. This consisted of a comminutor and a 3-section grease separating tank equipped with Link-Belt straightline collectors for skimming the floating grease and removing the settled material. Air performs the dual function of acting as a baffle and liberating grease; 200 to 300 cu. ft. per minute are used, with chlorine added at

(Continued on page 30)



A Carter 110′ rotary distributor at the Manville, N. J., plant.

Barber-Greene paver laying hot asphalt in Bangor.

Bangor Renews Its Streets with Hot Asphalt Paving

By JAMES L. MacLEOD
City Engineer

LIKE many other cities throughout the country, the city of Bangor, Maine, is now faced with the problem of resurfacing concrete roads and streets most of which have been in service many years. To provide for this surfacing program the City started in 1941 to acquire the necessary plant and equipment to do this work. At that time a Barber-Greene hot asphalt plant was purchased including the pug mill mixer, gradation unit, and single drum dryer and it was intended to acquire an asphalt paving machine in 1942. But due to the war all these plans had to be delayed. However, in 1945 the Barber-Greene Company was able to deliver a paving machine and a small start was made in our paving program. Fortunately funds were available to carry on this work due to the foresight of the City Council in earmarking a sizeable amount of money in a capital reserve fund. The State Legislature previously had passed legislation making the establishment of this capital reserve fund legal.

Bangor has 278,500 square yards of cement concrete roadway remaining to be surfaced. This is equivalent to 20.9 miles of 24-ft. pavement, all of which is scheduled to be covered with hot asphalt paving during the next five years.

In designing the proper type of mixture for the paving, a sieve analysis of our available material was made and a mixture designed based on federal and state specifications. Most of these specifications called for ½-inch stone as the maximum size. In striving to meet these requirements it was found that our crushing plant could not produce this stone rapidly enough. Accordingly we changed the maximum size to not over ¾-inch. The final paving mixture based on percentages by weight was 30% of ¾-inch fractured stone, 27% intermediate stone or buckwheat, 40% sand, and 3% fine material passing the 100-mesh sieve; 6½% by weight of 80 to 90 penetration asphalt was used as the binder.

This mixture while giving a slightly rougher looking texture does give a surface that provides more traction and consequently is less slippery when wet; and it also provides a mixture dense enough to prevent moisture from working down through. It has been observed that during the winter the snow and ice leaves this surface much more rapidly than from other types of pavement, and also the application of salt on this pavement during the winter does not seem to have any injurious effects.

The paving program was started about the middle of July and a total of 37,200 square yards was put down. A minimum thickness of two inches was used for the entire paving program, and where undue settlement in the concrete pavement existed leveling courses were put down.

Where it was necessary to raise existing manholes or other utility installations a cast iron rim two inches high was provided and welded to the existing rim and the cover then placed on this new rim. By doing this we eliminated the necessity of breaking out the existing concrete to raise the old rim.

The City of Bangor is the only city in the State at the present time which has a complete hot asphalt mixing plant and paving machine, and with the start of this paving program here considerable interest has developed throughout the State and without doubt other cities will follow this same procedure. These old concrete roads provide a very good base for this hot asphalt pavement and the surface gives excellent rid-

ing qualities as well as a very pleasing appearance along with the extended years of service. Much favorable comment has been received by the Department for the work that has been done and the speed with which a street was completed and thus returned to traffic. In no case during our paving program was any block closed to traffic for more than one-half a day.

By doing this work with our own forces and under our own supervision the cost to the taxpayer is about one-half the cost charged by contractors doing similar work.

Industrial Waste Treatment and Problems

(Concluded from page 28)

the rate of about 6 ppm., for flows averaging 26,500 gph. Average grease removal was 79.3%.[29]

Wool wastes, particularly those from sodium sulfide vats, may affect sewers. Treatment with ferrous sulfate in Los Angeles has resulted in recovery of enough sodium sulfide to pay for treatment.[4]

Gelatine wastes from an English factory consisted in part of lime water containing 1260 ppm. caustic calcium salts and 1840 ppm. of carbonates.[27] These caused heavy deposits in the sewer. The caustic lime was partly in a colloidal state due to the presence of grease and therefore was not susceptible to sedimentation. Experiments indicated the best treatment to be coagulation with alumina-ferric salts in amounts slightly greater than the lime content. Dilution of the lime waste with four times its volume of wash water helped; 24-hr. sedimentation gave best results.

Rubber wastes from rubber synthetic and reclaiming plants were found difficult to treat at Akron, O.[28] The waste particles have a specific gravity just below 1 and will not settle; some pass through the entire plant, including the trickling filters and are discharged in the effluent.

Phosphorous and nitrogen in sewage plant effluents may change the nature of aquatic growths, creating nuisance from the decay of these, as at Madison, Wisc. Removal of phosphorous from sewage can be accomplished quite readily by a trivalent coagulant, such as ferric chloride.[18] Reduction of total phosphorous to 0.5 ppm (soluble to .01 ppm) can be accomplished with 50 ppm. of ferric chloride. It is also possible to tie up both phosphorous and nitrogen in the sludge; certain industrial wastes containing carbohydrates can be used, but overtreatment would markedly increase BOD.

Glue wastes at Carrollville, Wisc., are treated by screening, dewatering conveyors, and settling tanks with Link-Belt equipment, including a rotating collecting trough.[31] Operating costs are covered by recovery of grease and of usable glue stock, and pollution conditions in Lake Michigan were reduced; scum and grease were no longer a problem on the lake surface.

Felt mill wastes were treated[32] with a Link-Belt vibrating screen, which operates 20 hrs. per day, handling an average flow of 200 gpm., with maximum flow of 500 gpm. The screen has 40-mesh openings and removes about 95% of the solids. In order to prevent nuisance in the receiving stream, the screen effluent is chemically treated before final discharge.

Tannery wastes were treated at Sheboygan, Wisc.,[36] by a Dorr screen having ⅛" openings. Screenings at the sewage treatment plant dropped to ½ cu. yd. per day (1/3 of the previous amount) following installation of the tannery plant screen; hair and lime have been removed and sewage plant operation improved.

TNT wastes do not yield to filtration through sand or stone. Treatment by combination with an alkaline waste and/or lime sludge from softening plants appears possible.[26]

Fish canning wastes amount to 2000 gals. of salt water per ton of sardines. This contains 5000 ppm. of organic solids. Progress is being made on reclaiming for by-products much of these solids. Since the sardine industry is near the ocean, most of the wastes are discharged into it, often causing local nuisance.[18]

1. Engineering News-Record, June 14, 1945.
2. Public Works, December, 1944.
3. Water Works and Sewerage, March, 1944.
4. Sewage Works Engineering, October, 1945.
5. Water Works and Sewerage, May, 1945.
6. Sewage Works Journal, May, 1944.
7. Water Works and Sewerage, November, 1943.
8. Sewage Works Journal, November, 1942.
9. Sewage Works Journal, September, 1943.
10. Water Works and Sewerage, March, 1945.
11. Sewage Works Journal, July, 1944.
12. Sewage Works Engineering, April, 1944.
13. Sewage Works Journal, September, 1945.
14. Public Works, December, 1945.
15. Sewage Works Journal, November, 1945.
16. Engineering News-Record, Feb. 25, 1943.
17. Water Works and Sewerage, October, 1943.
18. Sewage Works Journal, September, 1944.
19. Civil Engineering, January, 1944.
20. Sewage Works Journal, March, 1945.
21. Sewage Works Journal, July, 1943.
22. Sewage Works Journal, January, 1943.
23. Water Works and Sewerage, December, 1942.
24. Sewage Works Journal, May, 1945.
25. Water Works and Sewerage, February, 1944.
26. Sewage Works Engineering, August, 1943.
27. The Surveyor, October 1, 1943.
28. Sewage Works Journal, January, 1944.
29. The National Provisioner, June 6, 1942.
30. Link-Belt News, January, 1946.
31. Link-Belt News, January, 1943.
32. Link-Belt News, November-December, 1945.
33. Public Works, March, 1945.
34. " " July, 1945.
35. " " April, 1944.
36. " " August, 1943.
37. " " November, 1943.

Operation Records at Sewage Plants

In an article in *Sewage Works Journal* discussing the operation of the Elizabeth Joint Meeting plant, William Rudolfs and Edward P. Decker say: "The accumulation of operation records is primarily for the purposes of (a) indicating the degree of purification accomplished, (b) determining the effect of changing conditions, (c) serving as a basis for improvement and expansion, (d) measuring the efficiency and improvement in operation, and (e) determining total cost to the municipalities and the variation in cost with changes in operation."

In the same Journal, L. S. Morgan gives as the reasons for maintaining records: "(1) To indicate to the plant operator and responsible officials that the individual units of the plant and the plant as a whole are maintained and operated so as to produce the desired results. (2) To serve as the basis of reports to proper responsible officials. (3) To warn the operator of circumstances which may produce troubles in operation, with resulting lowered efficiency. (4) To serve as a guide for future operations in the light of past experience. (5) To serve as a permanent record of plant performance for use as legal evidence. (6) For reference as a basis for determining future treatment requirements."

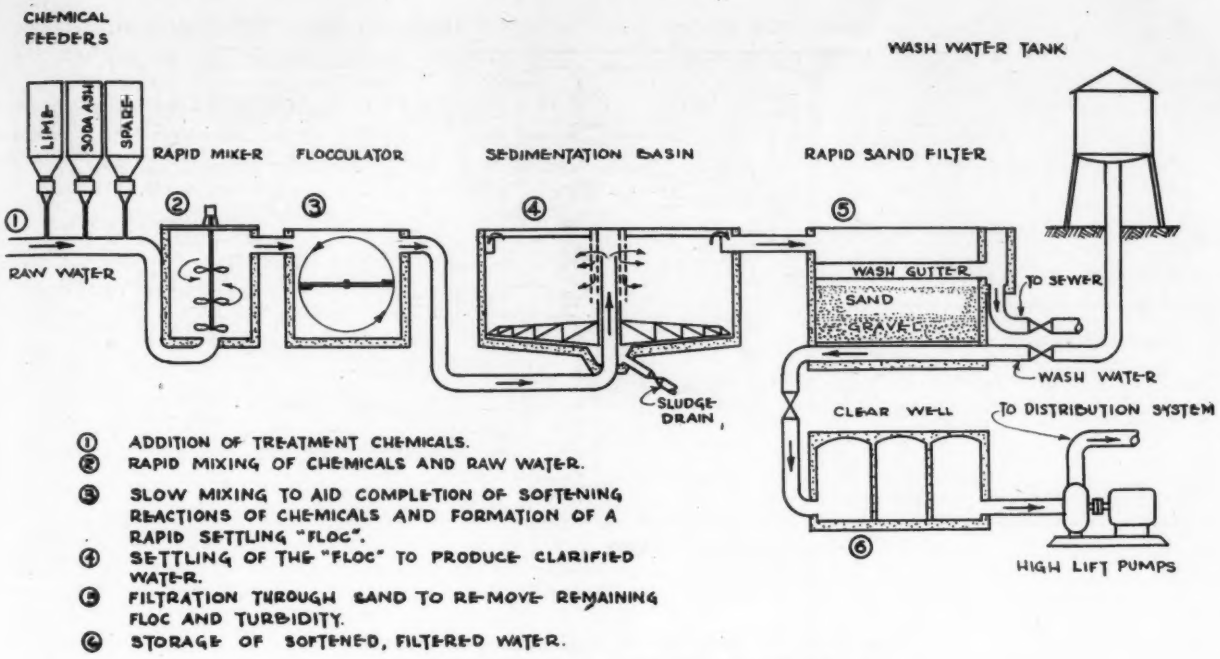


Fig. 1. Flow diagram of lime-soda water softening plant.

Scale and Corrosion Prevention by Chemical Conditioning of Water

Polyphosphates were used by the Army to prevent corrosion and scale formation. This article tells municipalities how they, too, can solve many of their problems by using these new methods and materials.

By R. T. HANLON, Chemical Engineer, and D. NEWTON, Sanitary Engineer
U. S. Army Corps of Engineers, R & U Branch, Utilities Division, Headquarters Sixth Service Command

NEW developments in scale and corrosion control permit many water departments to correct these conditions at low initial and operating expenditures. Scale and/or corrosion problems exist in nearly all sections of the United States, and frequently result in excessive costs to water consumers for cleaning and repairing water heaters and replacing piping and plumbing. While individual correction of these undesirable water characteristics by installing unit treatment equipment may be less costly than repair or replacement of fixtures, the most economical procedure is the proper treatment of the entire supply. The Water Department is created and operated for the benefit of the community and should perform these functions in respect to water supply which the citizens cannot readily perform for themselves or which it is cheaper to do collectively than individually.

It is not generally appreciated how great are the costs that may be imposed upon consumers by such factors as scale and corrosion. The experiences of the U. S. Army in the war just ended are educational and illuminating. The Corps of Engineers not only provided the water for our Army camps, but were responsible also for maintenance and repair of all utilities in these camps. Below are given some of the cost experiences of the Army[1] resulting from the use of scale-forming or corrosive water.

At Camp Phillips, Kans., previous to initiation of chemical conditioning of the water, the cost of repairs to hot water heating equipment averaged $387 per day, which was reduced by treatment to $20 per day. There were 125 failures of hot water heaters in a year at the Sioux Falls Army Air Base, S. D., before treatment, but after chemical conditioning of the water there was one failure in 8 months. In Camp Swift, Texas, hot water lines and relief valves on water heaters plugged completely with scale. Chemical conditioning of water was started in August, 1942, and by February, 1943, scale troubles had disappeared.

At Las Vegas Army Air Base, N. M., 25% of the hot water heaters had to be replaced and the probable cost of such replacement over a 2-year period was estimated at $35,000. Phosphate treatment of the water was applied early in 1944, and further replacement of heaters was not necessary. At Will Rogers Field, Okla., corrosion was only "moderately severe"; treatment resulted in a 50% reduction in troubles. At Fort Dix, N. J., after 3 years plumbing was so badly corroded, particularly at the threads, that replacement was necessary. Proper chemical conditioning of the water, resulting in the formation of a protective coating on the pipe interiors, eliminated the trouble.

The water at Camp Myles Standish, Mass., attacked

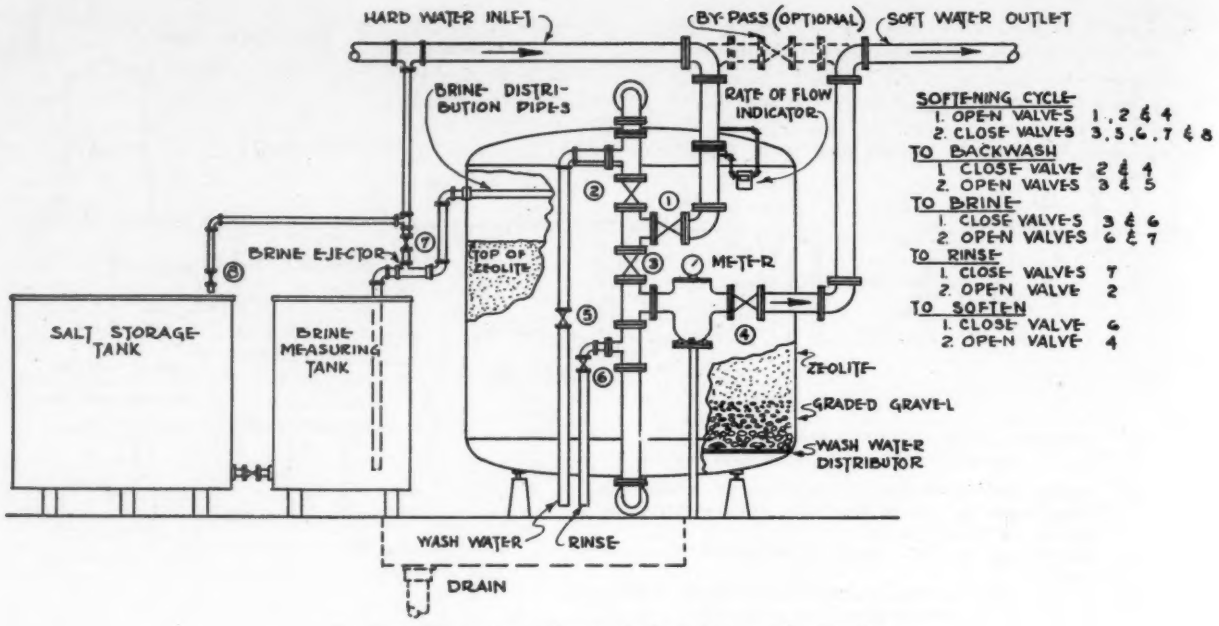


Fig. 2. Zeolite water softener, single unit, manual operation.

ferrous pipes and coils, brass fittings and fixtures. Chemical conditioning of the water resulted in forming a protective coating and elimination of corrosion. At Truax Field, Wisc., booster water heaters plugged quickly and there were frequent failures of boilers. This was corrected with phosphate treatment. A supply line at the Marietta Holding and Reconsignment Point, Pa., showed pits 1-32 in. deep in 15 months. Chemical treatment stopped further corrosion and also eliminated red water troubles at this post.

These few instances are typical of the general experience of the Army and are substantial evidence of what happens to consumers' piping, plumbing and heaters when a seriously corrosive or scale-forming water is supplied to them. The costs given are indicative of what many water users are paying in direct costs for lack of proper treatment of water by municipalities.

An analysis of 751 army water supplies all over the United States showed that 77% of them were corrosive and 22.5% of them had definite scale-forming characteristics, while some of them were both corrosive and scale-forming.

Since the work done by the Army during the past three years forms the basis for much of our knowledge of practical scale and corrosion control, it is desirable to review briefly the experiences leading up to the initiation of the work. As the war construction program developed, critical shortages, instead of engineering knowledge, governed the selection of materials for construction, repair and maintenance of water treatment plants and water-using utilities. It was necessary to substitute ferrous materials where proper engineering practice would indicate the use of non-ferrous materials, and to dispense with the installation of water softening systems, where proper engineering practices would normally dictate such installations.

As population of the Army facilities increased, with consequent increase in water consumption, and as it was attempted to meet the requirements of the Army Medical Department for 180° F. water for dishwashing and dishrinsing operations, it was observed that scale formation was a serious problem. In some posts, it necessitated acid cleaning of hot water heaters and auxiliary equipment at from 5 to 10-day intervals. In addition it was noted that accelerated corrosion of such equipment occurred where an Army installation was served with a water which was essentially corrosive in character. Maintenance costs of hot water systems, rendered frequently inoperative by formation of scale and because of corrosion, indicated that immediate action was imperative if operation not only of mess halls but of latrines and other facilities which were served with water at temperatures as low as 140° F. was to be economically accomplished.

Results of Army Tests

Review of available technical literature and inquiry to various manufacturers and distributors of water treatment chemicals indicated that scale formation had been prevented by application of concentrations of from 1 to 5 p.p.m. of certain non-toxic phosphate combinations. In addition it was known that corrosion had been inhibited by application of such phosphates, by utilization of lime and by the employment of silicates for the formation of protective coatings of metal surfaces exposed to contact with corrosive waters. However, since no evidence could be found that any of these treatment chemicals had been applied under the stringent conditions of temperature and water flow which characterize Army operation, it was deemed advisable to make a full scale test of Truax Field, Madison, Wisconsin, which was served with a typical scale-forming water, to determine the effectiveness of chemicals used for scale prevention. Tests were also made at other Army installations served with corrosive waters in order to evaluate the performance of chemicals designed to prevent corrosion. The results of these tests were reported by the Corps of Engineers of the U. S. Army in September 1944 and susequently published.[1]

These tests showed the following:

1. That it is possible by the use of phosphates substantially to inhibit scale formation with a water hardness as high as approximately 330 p.p.m. as $CaCO_3$ and at temperatures as high as 200° F. The average cost of such treatment was less than $2.50 per million gallons of water treated.

2. That more effective results are obtained with the use of poly or molecularly dehydrated phosphates such as septaphosphate[2] or sodium-hexametaphosphate[3] or combinations of such phosphates, than with essentially organic-phosphate combinations. Organic treatment, alone, appears to have no value in inhibition of scale formation.

3. It also was shown that a combination of a poly or molecularly dehydrated phosphate and sodium silicate properly proportioned and fed at a rate of approximately 5 p.p.m. for each of the treatment chemicals, substantially precluded formation of scale and conferred reasonable protection against corrosion.

Experience on a nationwide basis at Army Posts using septaphosphates, hexametaphosphates and other polyphosphates alone or in combination with silicates, and in some cases with soda ash for alkalinity adjustment, indicated that the results obtained at Truax Field in the control of scale formation could be substantially duplicated anywhere else within the range of hardness between 100 and 800 p.p.m. as $CaCO_3$.

Similar progress in the control of corrosion could not be accomplished due to limitations imposed by shortages of technical personnel and of materials necessary to complete comprehensive tests. Positive indications exist however that the application of phosphates similar to those used for scale control; and of silicates, alone, or in combination with phosphates or with lime, are partially effective as corrosion inhibitors.

Water Categories and Classifications

In order to treat water properly for prevention of scale formation or of corrosion it is initially necessary to determine whether a water is essentially scale forming in character or is of such composition that corrosion of ferrous materials with which the water is in contact will occur. This can be roughly determined by measurement of water hardness using the "soap test."[4] This test will yield a fairly accurate evaluation of the concentration of scale-forming salts contained in the water.

The following table is illustrative of the corrosive or scale-forming characteristics of water, based on concentration of hardness salts:

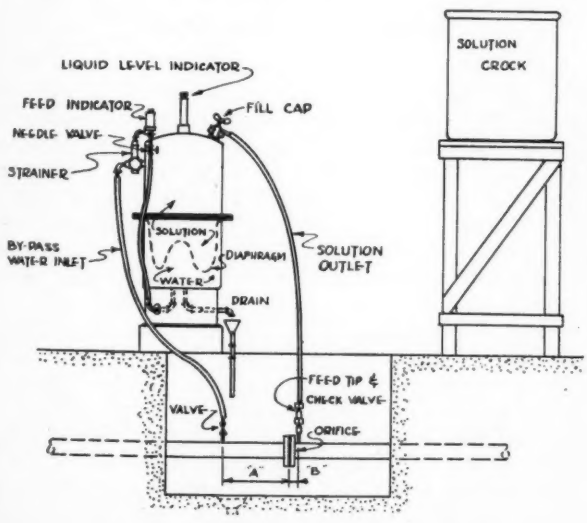


Fig. 4. Hydraulic type solution feeder.

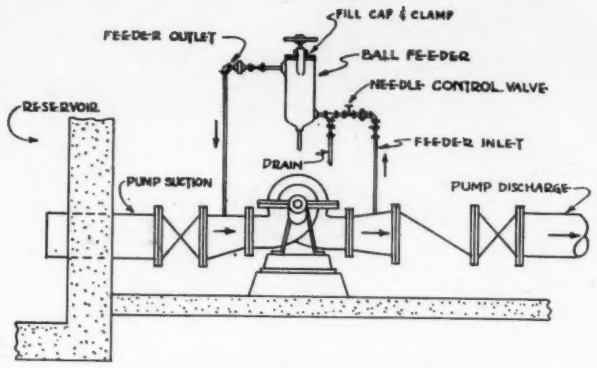


Fig. 3. Ball feeder installed with booster pump.

Hardness of water based on soap test as parts per million hardness salts expressed as calcium carbonate	*Degree of corrosivity or of scale-forming characteristics*
0-25	Extremely corrosive
25-50	Corrosive
50-75	Moderately corrosive
75-125	Slightly corrosive—scale forming
125-200	Moderately scale forming
200-300	Scale forming
300+	Seriously scale forming

The foregoing is not intended to convey the impression that all waters in the scale-forming category are free of corrosive characteristics. In fact, it has been the finding of investigators of the U. S. Army and others that a scale-forming water high in sulphate or chloride content, or one that is saturated with oxygen, may cause both serious scale deposition and intense general or localized corrosion.

Treatment of Scale-Forming Waters

General.—Scale-forming waters may be treated for prevention of incrustation by two methods:

a. Removal of scale-forming salts of calcium and magnesium before entry to the distribution system.

b. Chemical treatment of water containing calcium and magnesium salts for prevention of scale deposition.

Examples of methods of calcium and magnesium removal before entry to the distribution system are the lime soda and the zeolite base exchange processes. Since such processes may cause a water so treated to become corrosive, blending of some hard water with the effluent of these softeners or treatment of the effluent with chemicals designed to arrest corrosion is often necessary.

Chemical treatment of a scale-forming water, without removal of calcium and magnesium, may be effectively accomplished by the use of polyphosphates or phosphates of the molecularly dehydrated type.

While it is realized that the employment of a softening system, such as lime-soda or the zeolite process, will, if properly controlled, produce a water of superior quality for municipal or industrial use, initial and maintenance costs of such equipment often appear high. But because of the lack of such systems, many municipalities and industries experience extreme difficulty from scale formation and intense localized or general corrosion, in both cold and hot water systems. This difficulty may be almost totally precluded by the proper application and control of chemical treatment.

It should be initially understood that this type of chemical treatment does not soften water; nor can it confer protection against scale formation at temperatures in excess of 200° F. However, adequate protec-

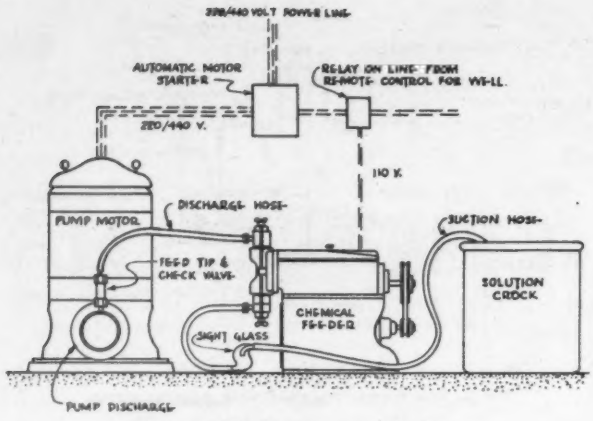


Fig. 5. Diaphragm-pump feeder.

tion against scale formation can be afforded to all water piping, hot water boilers, water heaters and hot water storage tanks, provided the operating temperature of such equipment is not permitted to exceed 200° F.

Procedures in Treatment.—Before treatment of any water system for prevention of scale formation and corrosion, it is necessary to survey the system to determine the maximum temperature to which the water is subjected and the condition of the cold and hot water equipment relative to the presence of scale and corrosion. In addition it is necessary to ascertain the chemical composition of the water supply and whether this composition is subject to variation as a result of seasonal changes or changes due to other factors beyond the control of the operating personnel.

If, as a result of such a survey it is determined that the water to be treated is subjected to a temperature in excess of 200° F. at some locations, it should be realized that chemical treatment of such water will not totally prevent scale formation at these locations. Under such conditions the installation of a unit softener to remove hardness salts from water so heated is advisable. If it is determined that certain parts of the water system to be treated are heavily coated with scale, or if corrosion is excessive, these parts should be acid cleaned before treatment is instituted.[5] Since the dosage of treatment chemical must be predicated upon water composition, one or more analyses of the water, dependent upon source and expected variations in composition, should be made. Such analyses should be for hardness, total alkalinity, calcium, magnesium, chloride, sulphate, iron, manganese, total dissolved solids and pH. The results of such analyses can also be used to predict the amount of scale which will form at any given temperature of a particular water.[6]

Polyphosphates, or those phosphates of the molecularly dehydrated type, are effective for prevention of incrustation, or for prevention of precipitation of iron and manganese, providing proper dosage to meet specific water composition is given. In the cases where water is to be treated for prevention of incrustation alone, the range of effectiveness is from approximately 1 to 10 p.p.m. of the treatment chemical. In cases where is is desired to sequester iron and thereby prevent precipitation of this material, it is necessary to feed additional phosphate *over that required for prevention of incrustation.* Experience has indicated in the case of prevention of precipitation of manganese, that treatment with phosphates is similarly effective only at low manganese concentrations, in the order of 1 to 3 p.p.m.

In cases where it is necessary only to treat for prevention of incrustation, due to presence in the water of calcium and magnesium bicarbonate, chloride or sulphate, a feed of from approximately 1 to 3 p.p.m. of the treatment chemical up to a water hardness of 400 p.p.m. as $CaCO_3$ will be effective in preventing incrustation. Where, however, a water exceeds 400 p.p.m. in hardness, additional feed of the phosphate may be necessary. Such increase in feed can be best predicated upon observed results in prevention of incrustation, and by determination of phosphate residual in the treated water. A method for phosphate residual determination is given later in this article.

Where, however, a water contains dissolved iron, it is usually necessary to feed 1 p.p.m. of the phosphate for each p.p.m. of dissolved iron up to 5 p.p.m. of the iron. Where a water contains in excess of 5 p.p.m. dissolved iron it is necessary to feed 1 p.p.m. of the phosphate for the first 5 p.p.m. of the dissolved iron and an additional 1 p.p.m. of the phosphate for each *additional* 2 p.p.m. of this iron.

For example, if a water contains 9 p.p.m. of dissolved iron and 300 p.p.m. hardness, calculation of treatment chemical feed, necessary to prevent incrustation due to presence of such iron, and of calcium and magnesium salts, which cause hardness of the water, will be as follows:

1. Feed of phosphate necessary to prevent precipitation of dissolved iron
   a. First 5 p.p.m. of iron—5 p.p.m. of phosphate
   b. Additional 4 p.p.m. of iron—2 p.p.m. of phosphate
2. Feed of phosphate necessary to prevent incrustation due to presence of 300 p.p.m. of hardness scale forming) salts—2 p.p.m. of phosphate
3. Total feed of phosphate necessary to prevent precipitation of iron and incrustation due to presence of hardness salts—9 p.p.m. of phosphate

Where a water contains not in excess of 3 p.p.m. of manganese, partial protection against precipitation of this material will be conferred by feed of 1 p.p.m. of the phosphate for each p.p.m. of the manganese present in the water. When a water to be treated contains in excess of 3 p.p.m. manganese, prevention of precipitation of this material is difficult and expensive by use of the polyphosphates. In such cases other means of manganese removal should be investigated.

Chemical Testing of Water

Unless water originates in a deep well or a large body of surface water, both of which are not seriously affected by seasonal changes, all waters which are treated with phosphate should be subjected to complete mineral analyses at least twice yearly and to partial mineral analyses, particularly for hardness, at least monthly. These analyses will disclose any important change in water composition and will permit adjustment of feed rate of the chemical to meet the requirements of changing water composition.

Since chemical feed to any water system must be adequate for prevention of deposition of hardness (scale forming) salts and for prevention of precipitation of iron and manganese, if such are present, it is essential that the feed of the treatment chemical be such that the following is accomplished:

1. Minimum dosages for prevention of scale formation and prevention of precipitation of iron and/or manganese are continuously given.

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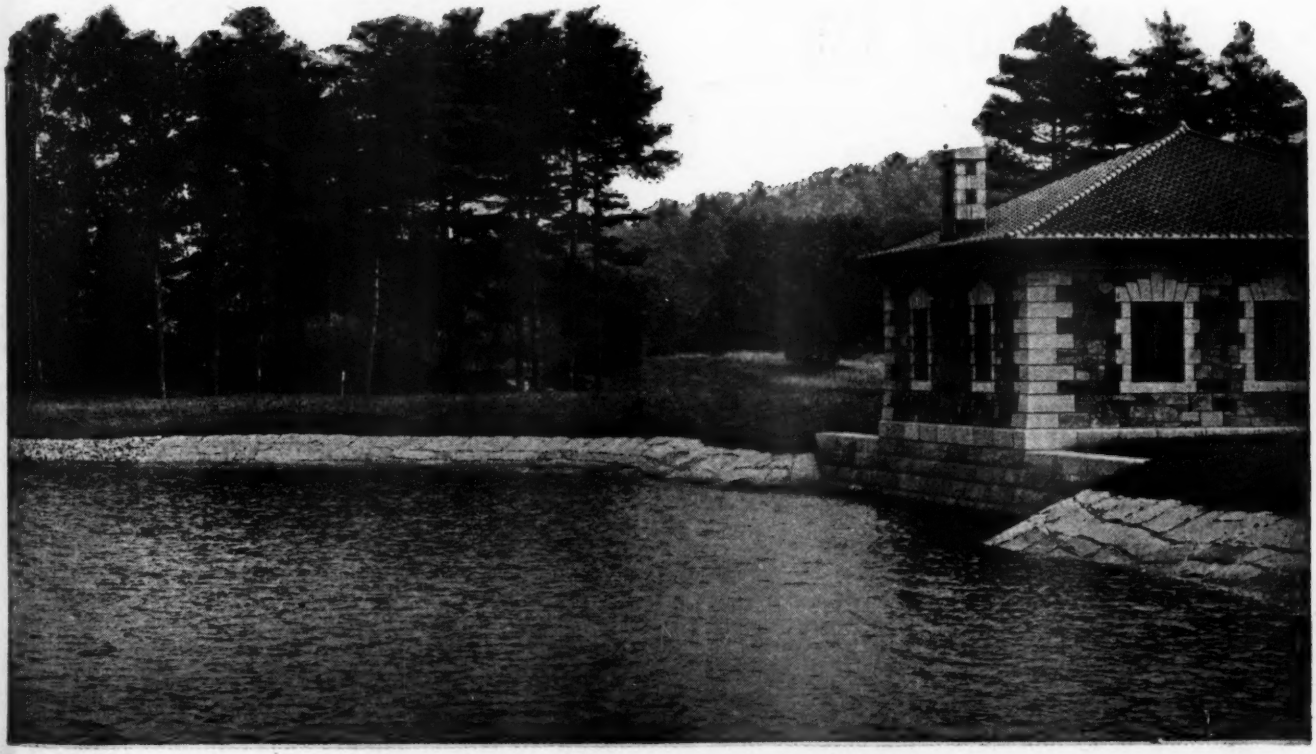

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2. Excessive feed of the treatment chemical, which will promote scale formation due to presence of hardness (scale forming) salts, must be avoided.

Both of these objectives can be best accomplished by the maintenance of a slight excess of phosphate in the treated water. This excess, which should not exceed 1 p.p.m., is known as the "residual phosphate." Samples for determination should be obtained at the end of the line or lines treated with phosphate. If samples taken at such locations show the presence of this residual phosphate, in the order of approximately 1 p.p.m., it will be known that chemical feed is adequate but not excessive for prevention of deposition of scale and for prevention of precipitation of iron and/or manganese. Dosage of treatment chemical can therefore be predicated upon the continuous maintenance of this excess.

A rough test for amount of residual phosphate in the treated water can be made as follows:

> Take 100 ml of the water to be tested, add approximately 3 ml of concentrated nitric acid and boil for 30 minutes. Add 2 drops of phenolphthalein indicator solution. Then slowly add a weak solution of caustic soda until the solution color is a faint pink. Then restore sample to original 100 ml volume using distilled water. Following this proceed with any standard low concentration phosphate test.[7] Phosphate content of sample is evaluated by density of blue color resulting from test procedure.

Treatment of Corrosive Waters

General.—Treatment of waters in the corrosive category may be accomplished by the following methods:

1. Addition of lime to the water.
2. Addition of lime in combination with 2 or 3 p.p.m. of the poly or molecularly dehydrated phosphates.
3. Increase in pH value of the water to approximately 8.0 by the addition of soda ash or caustic soda.
4. Addition of silica up to a total concentration of approximately 15 to 20 p.p.m. as SiO_2.

In some cases the addition of lime alone will confer reasonable protection against attack of the ferrous materials with which the water comes in contact. The lime, if added in sufficient quantity, eventually coats the metal surfaces of the equipment and pipelines and thus provides protection against such attack. Care should be taken when this type of corrosion protection treatment is applied, that the lime dosage is not applied in sufficiently large amounts to plug piping and water heating equipment.

Such plugging can be often precluded, and always minimized, by the addition to the lime-treated water of from 2 to 3 p.p.m. of the poly or molecularly dehydrated phosphates. Addition of such phosphates in these concentrations will prevent scale formation, due to excess lime, in the same manner as does similar treatment of scale-forming waters prevent incrustation.

In cases where it is not desirable to employ feed of lime, some inhibition of corrosion has been obtained by addition of either soda ash or caustic soda in sufficient amount to increase the pH value of the water to approximately 8.0 at 70° F. It is advised that in no case should either soda ash or caustic soda be added in sufficient amount to increase the water pH value above 8.5, since the action of chlorine is greatly retarded at such pH values, and a very much longer con-

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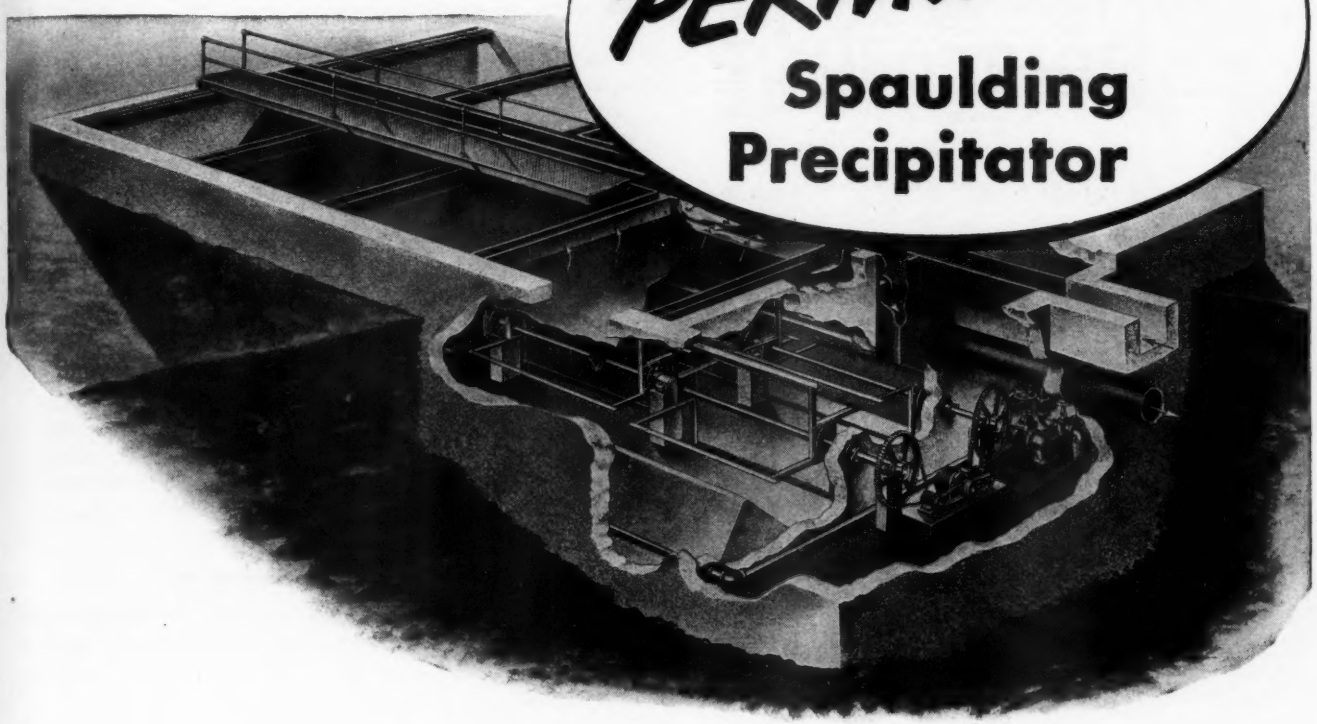

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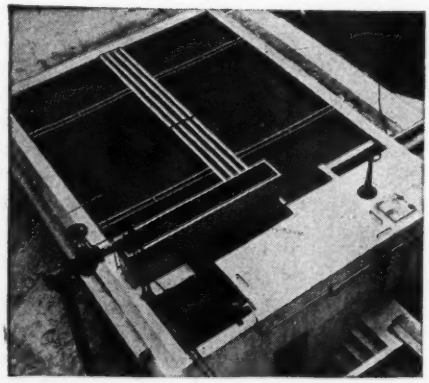

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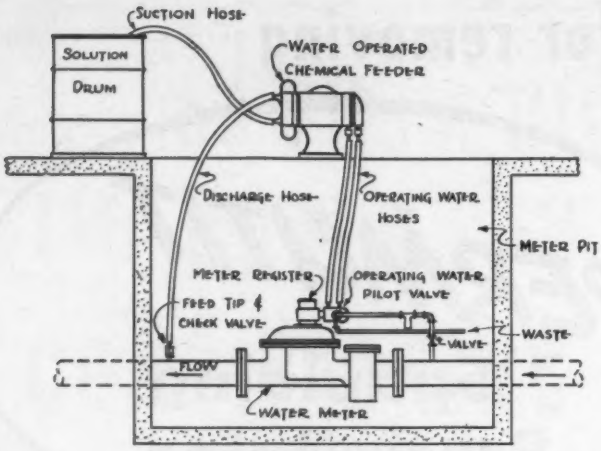

Fig 6. Water operated chemical feeder.

tact period is required to assure sterilization of the water.

In many cases silica, as sodium silicate, has been used with some success for inhibition of corrosive attack upon potable water lines and water heating equipment. Recent data indicate however that it may be necessary to feed this silicate at rates of from 15 to 20 p.p.m. in order to accomplish desired results. Insufficient data are available at the present time to indicate whether or not more effective corrosion inhibition is obtained when the feed of silicate is supplemented with either soda ash or caustic soda for the purpose of pH adjustment.

Procedures in Application.—As in the case of treatment of waters in the scale-forming category it is necessary to complete a survey of a system served with the water to be treated for corrosion inhibition. This survey should include determination of temperatures to which the water will be subjected, and the condition of equipment as regards the degree of corrosion present; and the possible seasonal or other variation in water composition should be determined.

If such a survey discloses that parts of the system to be treated are seriously corroded, these parts should be cleaned of corrosion products, or if necessary replaced.

Since dosage of treatment, as in the case of scale-forming waters, must be predicated upon water composition analyses of waters in the corrosive categories must be made as previously indicated for scale-forming waters. Such analyses should include hardness, total alkalinity, calcium, magnesium, chloride, sulphate, iron, total dissolved solids and pH.

Dosage and Feeding of Chemicals

In order to obtain best results in the application of treatment chemicals for prevention of scale and corrosion of potable water supplies it is necessary to consider two important factors. These are:

1. Dosages of treatment chemical in cases of phosphate treatment for prevention of incrustation must be maintained between 1 and 10 p.p.m., and within 1 p.p.m. plus or minus of determined or recommended dosage. Where anti-corrosion treatment is applied similar limits of polyphosphate concentrations must be maintained. In cases of silicate or lime feed, equally close control is often necessary.

2. Method of feed must be such that prescribed concentration of treatment chemical is continuously maintained in the treated water.

Since inadequate concentrations of the poly or molecularly dehydrated phosphates in the treated water will fail to preclude scale formation and since excessive feed of such phosphates will cause the formation of scale upon the water contacted surfaces of a system, extreme care must be taken in the concentration control of such chemicals. In the case of treatment of waters in the corrosive category where lime, lime-phosphate combinations and silica are used, equal care must be exercised in the feed of these chemicals and control of their relative concentrations in the treated water.

Since chemical feed, in cases of treatment of both scale-forming and corrosive waters, is often at the low rate of from 1 to 3 p.p.m., it is apparent that the selection of the point of chemical injection and the method of chemical feed may be the governing factor in the success or failure of the entire application.

It is therefore essential that the point of chemical injection be such that adequate mixing of the chemical is accomplished, before introduction to the actual water system. In addition, the method of feed must be such that maintenance of prescribed chemical concentration in the treated water is continuously accomplished.

In most cases, it will be desirable to work closely with the manufacturers of the particular phosphate or other material used. All of the reputable and established manufacturers maintain a thoroughly capable technical staff. Such personnel are invaluable in assisting in planning the surveys and analyses, in estimating initial dosages, and in recommending points of application for best results.

Types of Chemical Feeders

Feeders recommended for injection of treatment chemical to potable water supplies have been shown previously in this text. There are three main groups:

1. Diffusion or dispersion feeders.
2. Hydraulic solution feeders.
3. Pump type solution feeders.

1. *Diffusion or Dispersion Type Feeders.*—a. Diffusion Chamber.—This is the simplest type of feeder and is suitable only for feeding chemical solutions which dissolve slowly or are in a viscous state. It consists of a cylinder closed at the top and bottom, with a single pipe outlet at the bottom of the cylinder. This pipe outlet is connected by means of a tee to the water line which is to be treated. A fill opening is provided at the top. When such a chamber is used for feed of chemical in solid form, a screen is placed at the chamber bottom. When liquid chemicals are used, an orifice with a very fine opening is installed either in the outlet of the discharge pipe or in the bottom of the chamber. The principle of chemical feed employed is that of a constant slow diffusion of the chemical solution through the feeder outlet into the water line.

Application of this type of feeder is limited, in general, to very small water supplies such as in single homes or individual hot water services, where the need for accurate feed of water treatment chemical is not essential.

b. Ball Type Feeder.—This type of feeder, shown in Figure 3, is of simple design, but will yield reasonably accurate proportioning of chemical to water flow. It is suitable for feeding of solid chemicals only, preferably in ball briquette form. It consists of an iron chamber equipped with a bottom inlet, a top outlet and a large fill cap with a screw clamp. The inlet is equipped with a needle valve for control of the water by-passed through the feeder. The outlet connection

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is fitted with a gate valve to shut off the chamber during refilling operation. A drain is located in the inlet line between the needle valve and the feeder. The feeder is operated by means of a pressure differential obtained by the pressure drop across any suitable device such as an orifice, a venturi tube, a gate valve, or as shown in Figure 3 across a pump. A minimum pressure differential of approximately 2 pounds is necessary to create a flow of by-pass water through the feeder. Rate of chemical feed is predicated upon flow of by-pass water through the feeder.

This type of feeder can be applied to most systems where limitations of chemical concentration in the treated water do not exceed 2 to 3 p.p.m. plus or minus.

2. *Hydraulic Type Solution Feeders.*—In the hydraulic feeders a previously prepared solution of known strength is fed into the water line in proportion to the flow passing through a pressure differential device to the feeder. These feeders employ some device to prevent the by-pass water from mixing with and diluting the solution. The common methods are: Employment of a flexible diaphragm separating the feeder into two chambers; use of two separate chambers, one of which is filled with oil which in being transferred to the second chamber, displaces the solution without mixing with either the solution or the by-pass water; or an arrangement somewhat similar to that using oil, but with air as the intermediate fluid.

The type illustrated in Figure 4 employs the flexible diaphragm. The minimum pressure differential required for operation is from one half to one pound, which may be provided by an orifice, a venturi meter or a water meter. In some cases the feeder may also be connected across a pump, if equal pressures are present at the feeder inlet and outlet, when the pump is not operating. When water passes through the orifice a small amount of by-pass water passes through the needle valve, the sight feed glass and then the lower chamber of the feeder, causing a displacement of an equal amount of chemical solution through the outlet connection in the fill cap. A solution level indicator, consisting of a plastic marker in a clear plastic tube, raised by the diaphragm, is provided. This type of feeder requires that the water supply be shut off to insert the pressure differential device in the pipe line. Operation is simple, and the only features requiring attention are the needle valve, which may clog, and the diaphragm which may fail. Clogging of the needle valves is the main trouble in the feeders that employ oil as the intermediate fluid. The feeders using air usually incorporate some mechanical parts, such as oscillating measuring cups or small air compressors for replenishing the air supply. The usual attention to mechanical parts is required for these features.

3. *Pump Type Solution Feeder, Electrically Driven.*—Most of the electric motor driven pump feeders employ a diaphragm in place of the usual piston, but feeders for injection into very high pressure supplies are usually piston displacement pumps. The usual method of installing these feeders is to tap into the water pump discharge for the point of chemical injection and to connect the electric motor in such a manner that the feeder will operate automatically with the water pump. They may also be used to feed continuously or to proportion the chemical directly into a

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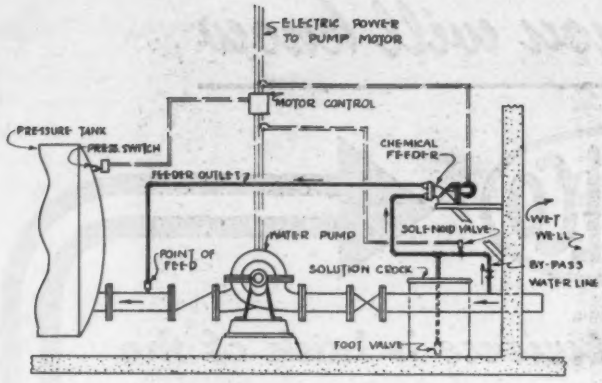

Fig. 7. Pump-type feeder.

water line. When proportioning directly into the water line, it is necessary to equip the water meter with a special head, embodying a device such as a mercoid switch, to make and break an electric circuit in proportion to the water flow. This switch in turn actuates a time relay, which may be set to permit the feeder to operate for any period of time that is less than the time required for one revolution of the meter head, at the maximum water flow. Installation of pump feeders is relatively simple and does not necessarily require that the water supply be shut off to make the one tap required in the pipe line. Clogging of the check valves in the pump head and in the feed tips may cause operating failures, although failure of the flexible rubber diaphragms may also occur. This type of feeder is shown in Figure 5.

Pump Type Solution Feeder, Water Operated.—This feeder is much the same as the electrically driven pump feeder except that the power is supplied by a water motor which usually consists of a second diaphragm attached to the same piston rod as the pumping diaphragm. Since the driving diaphragm is larger than the driven diaphragm an unbalanced force is produced which causes motion of the coupled diaphragms. The solution is thus pumped into the water supply. The operating water should be at a pressure equal to or greater than that into which the chemical is being injected. Such water is usually taken from the water line being treated. The operating water is alternated from one side to the other of the driving diaphragm by means of a pilot valve which is actuated by the piston movements in a constant pumping unit. In a proportioning unit, the pilot valve is controlled and actuated by a water meter through a special meter head. In both cases a control valve is provided in the operating water supply which permits control of the stroking rate and thus of the rate of chemical feed. Units of this type are especially adapted to installations in meter pits on purchased water supplies where electricity is not available. This type is free from difficulties due to power failures, broken V-belts and the like. The check valves in the pump head and in the point of feed are subject to some clogging and the diaphragms should be inspected regularly to insure proper operation. This type of feeder is shown in Figure 6.

Pump Type Solution Feeder, Electrically Driven for Intermittent Operation.—The installation shown in Figure 7 is especially arranged for installations where the water pump is controlled by a pressure switch on a small tank, and where operation occurs frequently for short periods of time. Any type of standard pump feeder is suitable for this type of application. The feeder operates continuously, pumping untreated water taken from the pipe line when the water pump is not operating. When the water pump starts, it also activates a circuit which closes a solenoid valve in the untreated water by-pass to the feeder. When the solenoid is closed the feeder draws solution from the solution tank and injects it into the water line. The solenoid valve opens when the pump shuts off and allows water to flush through the feeder and solution lines. This arrangement causes a time lag before the solution reaches the water line, and for this reason is not recommended when the water pump operates infrequently. Where this is the case, the electric motor on the feeder should operate in parallel with the pump motor and the water by-pass should be eliminated. The by-pass arrangement is desirable also, when the chemicals being fed are very viscous liquids or are relatively insoluble which would cause deposits in the feeder check valves and solution lines.

Conclusions

The experiences reported in this article as well as the experiences of other investigators, relative to chemical conditioning of potable water supplies for scale and corrosion inhibition, indicate that effective control of scale formation can be accomplished at low cost by utilization of poly and molecularly dehydrated phosphates alone or in combination with silicates, soda ash or caustic soda. Likewise partial corrosion inhibition can be effected by employment of lime, lime-phosphate combinations or of silicates.

Application of any of these chemical treatments can be successful only if injection of the chemical in the proper amount is accomplished at the proper point in the system to be treated, and if particular attention is given to design and operation of the feeder used for chemical injection. For this reason, particular attention should be given to the use of suitable chemical feeding equipment and to its proper installation.

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(1) Hanlon, R. T., Steffen, A. J., Rohlich, G. A., and Kessler, L. H., Scale and Corrosion Control in Potable Water Supplies at U. S. Army Posts, Industrial and Engineering Chemistry, Vol. 37, Page 724, August 1945.

(2) Obtained from National Aluminate Corporation, Chicago, Illinois, at Nalco 918.

(3) Obtained from Calgon, Inc., Pittsburgh, Pennsylvania, as Calgon.

(4) For method of determination of water hardness using the "soap test" see Analyses of Water and Sewage, 1st Edtiion 1935, pages 11-12. Theroux, Eldridge and Mallmann.

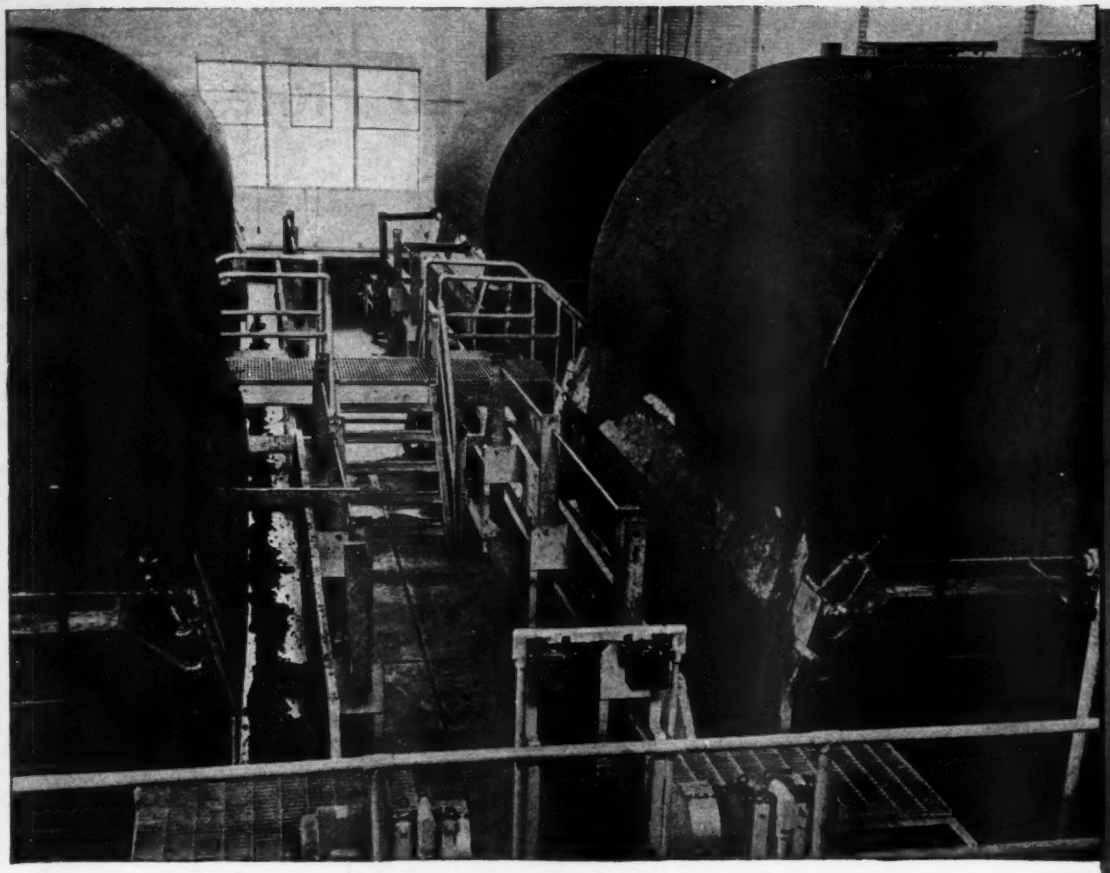
(5) Oakite compound No. 19 or No. 32, or a similar inhibited acid may be used for this purpose.

(6) Ryznar, John W., National Aluminate Corporation, A New Index for Determining Amount of Calcium Carbonate Scale Formed by a Water. Journal of the A.W.W.A., Vol. 36, No. 4, April 1944.

(7) For details of test for small amounts of phosphate contact W. A. Taylor and Co., 7300 York Road, Baltimore 4, Md., or Hellige, Inc., Long Island City, N. Y.

Denver Water Board Plans Enlarged System

A federal allocation of $50,000 has been made to the Denver Water Board for the purpose of preparing plans for enlargement of its Moffat tunnel water diversion system through the construction of a 9½ million dollar dam and storage reservoir on the eastern slope. The concrete dam is planned to impound about 68,000 acre-feet of western slope water, but it is not yet certain where the damsite will be located and the project is still in a tentative stage, conditioned on many factors.



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Use of Proprietary Equipment and Processes in Sanitary Engineering

A committee of the American Society of Civil Engineers was appointed in 1944 "to evaluate the professional objectives of engineering in designing water purification and sewage treatment works with reference to the influences of proprietary equipment and processes upon the development of effective and economical plans that will best meet the need of the community or industry to be served." The report of this committee was published in the Proceedings *of the society for January 1946, and an abstract of the more important points is given below.*

DURING the past decade a number of process patents relating to the treatment of water and sewage have been issued and are being actively promoted commercially by the assignees, many of whom are in the business of manufacturing and selling plant equipment. The promotion of patented articles and processes in the field of water and sewage treatment is not new, of course; but the practice has grown to such an extent recently that it threatens to interfere with conventional practice in the design of sanitary engineering works. Significant facts that have been brought to the attention of the Committee are as follows:

a. The patents involved and the threats of claims for infringement have become so numerous that the engineer is more or less restricted in design, since he has no means of knowing what may be covered by patents or whether or not claims of infringement may be made.

b. When he is informed of the coverage of a patent, he must decide between three alternatives: (1) To honor the patents, subjecting his client to the payment of royalties and to restriction of competition in bidding; (2) to infringe the patent and thereby subject his client to the possibility of expensive patent litigation; (3) avoid use of the patented process or design. The last is least troublesome but may deprive the client of the use of a valuable process or equipment, and may unknowingly infringe another patent.

c. Many of these patents seem to be of doubtful validity, which can be determined only by an infringement suit. Most of them have not been so established, yet it is the engineer's duty to his client to form an opinion as to its validity.

d. Some of the process patents obtained in recent years appear to be restrictions on established practice in that they purport to cover combinations of processes which have been previously used, or to established limits on certain design factors or rates that may be used without infringement.

e. Licenses for the use of certain patented processes are not usually readily obtainable by direct purchase, but are furnished to purchasers of equipment. This practice tends to force the use of equipment made by one manufacturer and thus to remove these articles from competitive bidding, even though equivalent equipment may be available.

f. In some cases, patent claims have been construed and interpreted to bidders in such a way as to restrict competition on plant equipment which would normally be considered as having no connection with the patented process.

g. Some manufacturers offer to an engineer, or to the client directly, free engineering services in designing a plant. These are necessarily biased and automatically eliminate competition; and there is danger that the plant as a whole will not be well designed.

h. Some engineers have presented these manufacturer's plans as their own; have even, it is reported, selected a method of treatment on the basis of whether the manufacturer would furnish working drawings for the completed design.

i. Some of the manufacturers who are promoting patented processes actively have made claims of efficiency or economy for their processes which have subsequently been found to be exaggerated. Operating data represented to be typical have been found, upon investigation, to have been collected over short periods of time and under particularly favorable circumstances. Construction cost estimates, upon examination, have been found to have been based upon unit costs far below prevailing bid prices.

The committee has endeavored to describe clearly the position and the necessary restrictions of the three groups in order to bring about a more satisfactory relationship between the Client, the professional Engineer, and the Promoter, to the end that all may benefit.

The committee cannot study the relative effectiveness of different processes—this is the most important duty of the engineer. Nor can it pass upon the validity of patents or patent claims, which is a matter for the courts.

Laws require many public agencies to award contracts to the "lowest responsible bidder"; others require competitive bidding; and it is considered good professional ethics that the engineer have no financial interest in any of the contracting firms that tender bids or in any article or process specified.

Where competitive bidding is compulsory, officials have been unable to obtain patented articles or processes in jurisdictions where the "Wisconsin" or "exclusion" rule applies; but in other jurisdictions, statutes requiring competitive bidding have been interpreted as not applying to patented processes or articles (the "Michigan" or "permissive" rule). In order to secure some competition with patented articles, two additional rules known as the "equal opportunity" and the "alternate" rules have been adopted in some states. Under the "equal opportunity" plan, all bidders have an equal opportunity to secure the patented portions of the specifications upon the same terms from the patent holder. Under the "alternate" rule, alternate bids are taken on several articles or processes serving the same purpose, including one or more patented articles or processes.

The right to specify a patented article does not

authorize a public agency to include it in one contract with work which is unpatented and capable of separate performance and for which competition can be secured. A contract so awarded is not valid even though competition may be obtained in the bidding. Furthermore, no insurmountable barrier exists to the acquisition of patented articles by public bodies. Any judicial or statutory impediments can be removed by appropriate remedial statutes, as the source of the problem is legislative.

The legal compulsion for competitive bidding does not apply to private persons or to industries, and many of these purchase directly from the manufacturer, who also furnishes the engineering service.

The "Canons of Ethics for Engineers" prepared by the Engineers Council for Professional Development does not call upon the engineer to avoid financial connections with proprietary processes and equipment, but to "make his status clearly understood to his client or employer before undertaking an engagement if he may be called upon to decide on the use of inventions, apparatus, or any other thing in which he may have a financial interest."

Licenses for the use of patented *processes* are generally obtainable only by purchasing equipment made by the owner of the process patent, thus limiting competition; but recent interpretations of patent law seem to indicate that the owner can be forced to sell a license to use a patented process without requiring the purchase from him of unpatented equipment for use in connection with it.

There is a widespread belief that satisfactory tests of new processes to determine their merit cannot be made in the laboratory or by pilot plants, but must be made on a fairly large scale, which involves considerable time and expense. But "Science and engineering practice have now developed to the stage where it is quite feasible to 'prove' a process or piece of equipment by laboratory or pilot-plant methods."

Many of the advances which have been made in water and sewage treatment have come through the protection of patents. The research, development, and promotional work costs money. Unless patents can be used to protect the chance for profit, there will be no incentive for progressive research. Patents are used for this purpose in every field of endeavor. They are the backbone of progress. It is the opinion of the Committee that patents should be recognized and honored by sanitary engineers until unmistakable evidence is available that they are not valid. Unfortunately, the law is such that a patent can be brought to the attention of a court only by means of an alleged infringement followed by suit on the part of the patentee. It is the duty of engineers therefore not to condone or support infringements unless the proposed infringement is preceded by a thorough legal examination of the patent, a thorough engineering study of the process, or both, and unless these investigations indicate clearly that a court test is desirable for the protection of the public.

An infringement suit is an expensive procedure which is avoided by proprietary interests if practicable. One method of avoiding such suits is to ignore infringes if not too numerous or to grant courtesy licenses to them. Another method is to extend licenses to competitors who might otherwise infringe. The practice of exchanging licenses is becoming more common among the proprietary interests dealing in processes and equipment for water treatment and sewage treatment. This is a desirable trend in that it promotes more competition in public lettings.

Engineers for public agencies have complained that in some cases patent claims have been so construed and have been so represented to bidders that competition has been restricted on plant equipment that would usually be considered as having no connection with the patented process. The remedy for this, in the opinion of the Committee, is for the client to assume full liability for infringement. The practice of specifying that the contractor should assume infringement liability has doubtful legal standing at best. The bidder is usually required to submit his proposal within a few weeks after receiving access to plans and specifications. If the plans involve new processes or equipment, it is obvious that there is insufficient time for him to evaluate the liability of infringement.

One of the greatest services that an engineer can perform is to make a thorough preliminary study and report on what is required for a client. Such a diagnosis is pure engineering of the highest type and is more costly the better the engineer; but in the end, if done well, it will result in best services at lowest cost to the client. It is the responsibility of the individual engineer to sell these principles to a prospective client, and once having sold them to retain confidence by maintaining high professional standards in the remainder of the work.

In the matter of water treatment and sewage treatment, a study of the water or waste to be treated and a study of the methods of treatment available which will produce the desired result economically would seem to be essential preliminaries to the selection of a process and the design of a plant. The obvious method for making such studies is by laboratory and pilot-plant tests. Consulting engineers serving municipalities have in general been backward in furnishing this type of service. Proprietary interests have not been backward, and their success in dealing directly with public agencies in regard to this type of service is evidence that public officials are alive to the need of it.

The Committee believes that the best and most economical selection and design of a treatment process and plant can be obtained if the client engages an engineer for that purpose, provided, however, that the engineer is a competent expert on processes and makes thorough studies of the available processes suitable for the project. The Committee further believes that most reliable proprietary interests would prefer to deal with competent engineers rather than directly with clients in order to insure a fair test of their processes by impartial experts. In the long run their success depends upon the existence of satisfied clients.

The responsibility for successful and economical performance of a treatment plant rests with the engineer, and he should assume the full responsibility for the design, selection, and testing of processes. He may properly enlist the cooperation of the United States Public Health Service, state departments of public health, or other suitable agencies in his studies and tests of treatment methods; but the responsibility for the results remains with the engineer and cannot be shifted to others without impairment of his professional standing as a process expert.

The responsibility for the development of the art of water treatment and sewage treatment rests squarely with the engineering profession. The public looks to the professional engineer as the legitimate expert in this field. If he is to maintain this position, he must support research and development actively, and he must be prepared to examine and test new developments, with competence, to the end that the public

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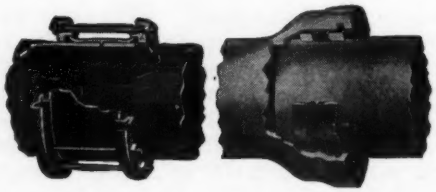

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A Four-Point Program for the Automobile Parking Problem

Miami Beach, Florida (28,012), which has a greatly increased population during the winter months, has just embarked on a comprehensive attack on the automobile parking problem, the acuteness of which is indicated in part by the fact that the city has 22,000 hotel rooms and 10,000 apartment units largely occupied during the winter by people who arrive in the city by automobile. More than 100,000 cars enter and leave the city each day over the three causeways which afford access to the city. With a view to providing adequate parking space in all commercial and multiple-family areas a four-point program has been adoped:

1. The city will utilize for parking purposes property already owned by the city in close proximity to the business district. The first step is now under way on the municipal golf course where provision is being made for parking 400 cars; this project will be extended as need arises to accommodate 1,000 cars. Tracts owned by the city in other areas will accommodate 900 cars.

2. The city will acquire by purchase off-street parking areas in sections where city-owned property is not now available. This will be done on a limited experimental basis if a proposed bond issue is approved.

3. Parking stations will be established at intervals on certain main business streets. At these points bonded attendants will take charge of cars for those desiring the service and park them in the parking areas provided by the city. Cars will be returned to owners either at the station where originally left or at any other station at which they may call. These stations will be about two blocks apart with closer intervals in the more crowded areas. A nominal charge will be made for this special service, which cannot be placed in operation until manpower is more plentiful. It is expected that street parking may be eliminated in locations where this plan is in operation.

4. Parking meters will be installed on business streets near the ocean and on other business streets where off-street parking has been or will be provided, and in off-street parking areas. The meters will be installed only for the purpose of regulating traffic and making possible the efficient use of parking space. Their use is the only means that has been devised which makes it possible for a police officer to determine whether a car has been parked longer than is permissible in a given location. Efforts in the past to accomplish this result with foot patrolmen have been only about 50 to 60 per cent effective.

The parking areas outlined in item 1 will cost about one-half million dollars for land and development as parking areas, or approximately $500 for each car space. The areas the city proposes to purchase under item 2 will cost on the average, including development as parking lots, in excess of $750 for each car space. It is proposed that all net operating revenues derived from the use of meters and the use of parking areas will be used to acquire and develop additional property as parking lots so that adequate parking space will be available at a nominal charge. The charge proposed

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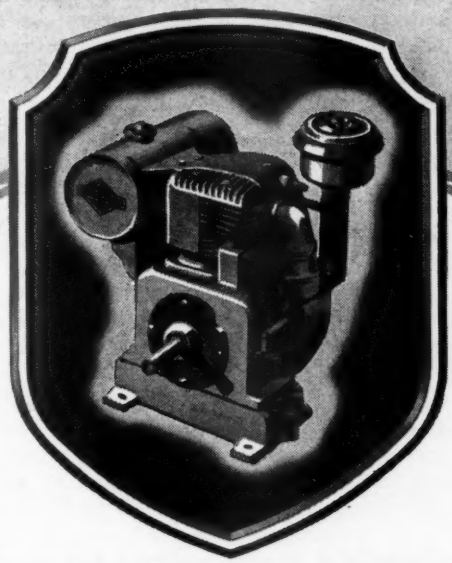

Look with confidence to Briggs & Stratton 4-cycle, *Air-Cooled* engines — "preferred power" in all fields — for the latest and most advanced developments for every application requiring ⅔ to 6 H. P. The Briggs & Stratton organization—with its concentration of technical knowledge, modern plants, equipment, and skilled workers—builds gasoline engines which are more than equal to today's most exacting power and performance requirements. You can expect *and get* more value per dollar if the appliances, farm machines or industrial equipment you buy, sell or make are powered by Briggs & Stratton.

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during the trial period is five cents for one or two hours on streets, depending on location, and five cents per hour or 25 cents for all-day parking on the off-street areas.—*Claude A. Renshaw*, city manager, Miami Beach, Florida, in *Public Management*.

Provisions of Chicago's New Refuse Removal Ordinance

Clarification of responsibility for refuse removal and establishment of specifications for standard refuse containers are provided in the new refuse removal ordinance of Chicago, Ill., which is summarized in the *News Letter* of the American Public Works Association as follows:

1. Refuse removal by the city is provided for: (a) All single dwellings; (b) Multiple dwellings containing fewer than five apartments; (c) Multiple dwellings containing fewer than 20 rooms; (d) Multiple dwellings producing fewer than 32 gallons of refuse per week; (e) Multiple dwellings, each living unit of which is heated by the tenant; and, (f) Occupational units which produce less than 32 gallons of refuse per week and which are also individually heated by the tenant.

2. Private scavenger service: The removal of refuse from all establishments, other than those listed above, is the responsibility of the owner or occupant. These establishments may, in general, be classified as occupational units producing more than 32 gallons per week or multiple dwelling units other than those listed above. In the case of occupational units, the removal is the responsibility of the occupant, in the multiple dwelling units it is the responsibility of the owners.

3. Duty to provide refuse containers: (a) "Standard refuse containers" shall be furnished for all city collections and for all refuse kept outside of buildings. No separation of refuse is necessary for city collection (single dwellings and occupational units, by occupants; multiple dwellings, by owner). A standard refuse container shall be of not less than 20 nor more than 32 gallons capacity, with tight fitting cover and equipped with two handles, and shall be subject to the approval of the Commissioner of Streets and Electricity. Enforcement of the use of the standard refuse container has been deferred by ordinance to January 1, 1947.

(b) "Sanitary refuse containers" shall be furnished for all private collections, (multiple dwellings, by owner; occupational units, by occupant). A sanitary refuse container shall be constructed of water-tight material and shall be subject to the approval of the Board of Health.

4. Location of container for city collections: (a) Alley collections—at alley line on premises served; (b) Curb collections—at curb line on day preceding the day of collection. No container shall be placed as to constitute a nuisance to adjacent property.

5. Private scavenger equipment: (a) Application for licenses shall be approved by the Board of Health and the Department of Streets and Electricity; (b) The annual license fee shall be $100 for each vehicle; (c) Each vehicle shall be annually approved by the Dept. of Streets & Electricity, (d) Rejected equipment shall be replaced with modern enclosed equipment; (e) Each licensed vehicle shall display an emblem stamped "Chicago—Private Scavenger"; and (f) Customers of private scavengers are required to display a plate stamped "Private Scavenger Service Rendered by (Name)."

Private Water System Pays City

In Wichita, Kansas, where the water supply and purification system is city-owned but the distribution system is privately owned and operated, the company under the present franchise agreement collects and turns over to the city a 15 per cent surcharge which last year amounted to $125,368. In addition, the city charges the company $10 per million gallons of water delivered to the company which brought in a revenue of $63,100, and also 50 per cent of the company's net earnings in excess of an amount allowed as a reasonable return, the amount received from this source being $20,850.

Aluminum Paint in Sewage Plants

At the Racine, Wis. sewage treatment plant, the channels of the grit chamber are painted with aluminum paint down to the water line and with bituminous paint below. Says Thomas T. Hay, Supt. of the plant: "A word of caution is warranted on the use of aluminum paint in channels containing sewage. If the aluminum paint is carried below the water line, the paint in connection with the iron in the equipment for grit removal will set up a most active electrolytic cell causing rapid deterioration of the equipment. We know—it happened to us." However, all surfaces above the sewage that come in contact with the grit are painted aluminum.

Tackling the Parking Problem

In Hartford, Connecticut, the mayor has appointed a development commission to study problems relating to the city's future including traffic, parking, and industrial expansion. A study of parking practices in Detroit indicates that the cost of parking is secondary to walking distance. Motorists paying a 10- to 15-cent parking fee walked an average distance of 820 feet according to the study, and those paying a 40-cent fee walked an average distance of 750 feet. The Chicago city council recently adopted a resolution requesting the state legislature to permit Chicago to establish and operate municipal parking lots; and a plan for building an underground parking lot in Grant Park also is being considered.—*Public Management*.

Street Maintenance Practices

A survey of street maintenance practices in seven cities, made by the American Public Works Association, shows that in Buffalo, New York, brick pavements are repaired with cold patch or asphalt. In Lansing, Michigan, all graveled streets are given calcium chloride treatment, usually twice during the summer period. Berkeley, California, reports unusual success in the use of the heater planer. The planer is used to remove rough places in the streets prior to resurfacing. With regard to maintenance of concrete pavements, Lexington, Kentucky, removes damaged places and repairs with concrete; Watertown, Massachusetts, keeps all cracks and joints filled or sealed with asphalt emulsion and covered with rice stone; Cedar Rapids, Iowa, uses asphaltic crack-filler; Minneapolis fills joints and cracks with 85-100 asphalt.

Water Supply for the Stilwell Road

(Concluded from page 22)

Personnel.—There was a shortage of Sanitary Corps personnel assigned to water supply in this area. The type of plant and the shortage of trained operators necessitated almost constant supervision. Five Sanitary Corps officers would not have been an unreasonable number and they could have devoted part time to other sanitary work. Officers with Malaria Control Units were too busy with their work (until later in the campaign) to be able to devote much time to water supply.

This project was admirably suited to a Water Supply Company, which could have been used to good advantage in operating water purification units for units which did not have trained personnel. Since this was not available a school for training water plant operators should have been established. This was not done because of the shortage of trained teaching personnel.

Policy.—It has been known for years that ordinary chlorination would not destroy the amebic cyst; it was also known that the filter supplied by the Army would not remove the cysts if operated at anywhere near the design rate; yet no definite policy was set up on water purification in areas where amebic dysentery was present until 1944. Diatomite filters were not in production until 1945 and none was ever received in Advance Section IBT. Super- and de-chlorination as a means of water purification was not made public until 1945. The exact amount of chlorine required to kill the cysts was not satisfactorily determined until 1945. All of these factors tended to confuse the issue in the field. It would appear that all of these problems could have been solved by the Army many years ago and thus made the war time problems much easier.

The failure to use shallow wells to the fullest extent seems inexcusable. True, hypochlorinators were not always available but they could have been (and were later) improvised. Failure to use shallow wells was due to the reluctance, on the part of the Engineers, adequately to protect these wells from surface contamination, as well as reluctance on the part of the Surgeon to approve them had they been protected. Of course, the Sanitary Corps comes in for its share of the blame by not being able to convince the proper authorities of the advisability of using these wells.

There was never a sufficient supply of deep well pumps nor well drilling equipment in the area. These could have been used much more extensively in the Ledo and Myitkyina area. This equipment was requisitioned early in 1944 but did not arrive in any quantity until 1945. Much more effort should have been expended towards getting this equipment on the ground.

Improvisations in water supply equipment were not started early enough to be of any real value. It was not until 1945 that tanks were improvised, plans were drawn for home made sand filters etc. If the same amount of ingenuity, time and effort had been directed toward water purification equipment as was directed towards equipment for boiling the picture would have been much different.

Laboratory facilities were inadequate in the first part of the program and even after they were made available they were not used to capacity (until the spring of 1945). Had laboratory analyses been available enough evidence could have been produced very quickly to prove that water can be purified without resorting to boiling.

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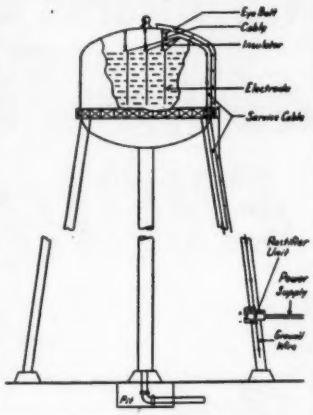

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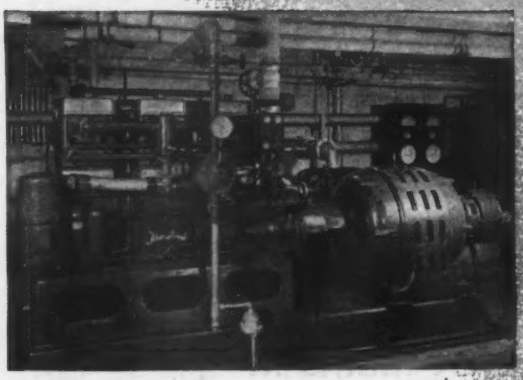

●75 H.P. Climax Sewage Gas Engine Direct Connected to Generator, Sewage Treatment Plant, Davenport, Iowa.

58½" High
72" Long
31" Wide

● New, Compact Climax V8 Engine.

★ SAMPLE COMMENTS ★

E. B. LLOYD, Chief Engineer and Chemist, Elgin City Water Department, says, "The reliability of this (Climax) standby equipment is a factor in keeping our city in low insurance classification."

SUPT. DAVID BACKMEYER, of Sewage Treatment Plant, Marion, Indiana, says, "To duplicate work done by the Climax Gas Engine in one year would require 191,000 kw hours. The three engines earned $7,771.68 in one year."

JACK STURDY, Supt. City Light and Waterworks, Tipton, Iowa. "Our Climax standby unit is 100% O.K."

CARL DUY, Engineer of Waterworks, Aurora, Illinois, (speaking of Climax Engines direct connected to 4 M.D.G. booster pumps in standby service) says, "For the past two years, since this writer has been in charge of plant, we have had no maintenance cost and they operate on regular schedule."

ROY M. BROWN, Chief Engineer, Department of Utilities, Provo City, Utah. "This (Climax) unit has proven satisfactory in every respect."

SUPT. H. T. RUDGALL, Sewage Treatment Plant, Kenosha, Wisconsin, says, "The (Climax) engines are economical because use of same provides a substantial saving over electric driven equipment."

IN WATERWORKS: In standby service, Climax Engines are not only used to supply—at a moment's notice—dependable power during purchased power outages, but—to keep down maximum demand charges for electric power during emergency periods of peak water demand. Because of their extremely low maintenance and economy of operation on natural or by-product gas, as well as on butane or gasoline, they are used as the source of *primary* power in many plants.

IN SEWAGE PLANTS: Records (available on request) of sewage plants from coast to coast affirm that Climax Engines, operating efficiently on sewage gas, have reduced power cost to the equivalent of ¼ cent per kwh. Savings thus affected have been supplemented by 50% heat recovery from jacket water and exhaust to heat digesters and buildings.

Consider Climax Engines **before approving a new installation. There are 4, 6, 8, and 12 cylinder, 4-cycle types. For complete information and specification bulletins, write Climax Engineering Company, Clinton, Iowa.**

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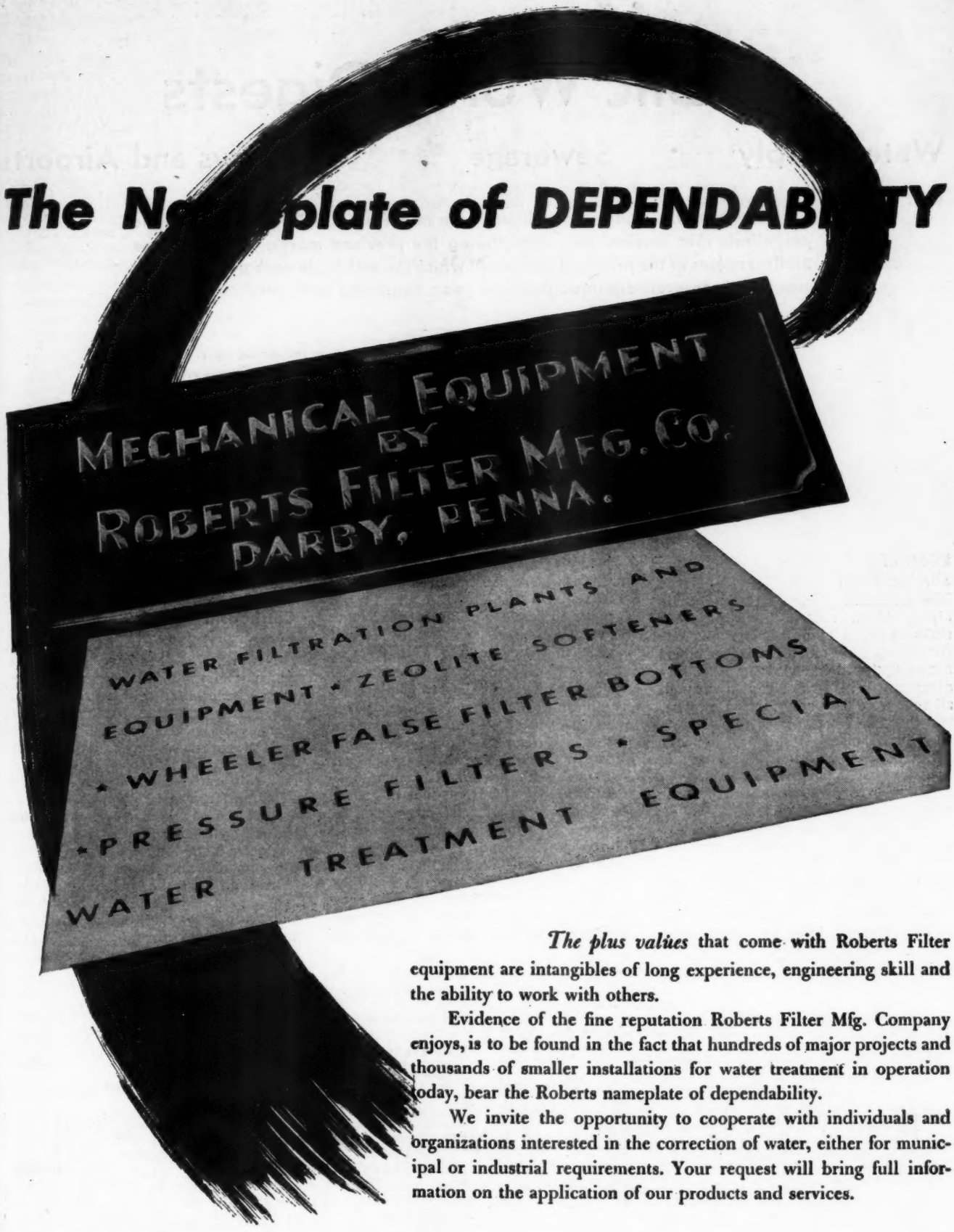

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Evidence of the fine reputation Roberts Filter Mfg. Company enjoys, is to be found in the fact that hundreds of major projects and thousands of smaller installations for water treatment in operation today, bear the Roberts nameplate of dependability.

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When you need special information—consult the classified READER'S SERVICE DEPT., *pages 79-81*

Public Works Digests

Water Supply • Sewerage • Highways and Airports

In this section are digested and briefed the important articles appearing in the periodicals that reached this office during the previous month. Appended are Bibliographies of the principal articles, in which the articles in each periodical are numbered consecutively throughout the year, beginning with our January issue.

The letter and number at the end of each digest refer to those used in the Bibliography. Numbers not found in the current Bibliography will be found in the one published the previous month.

The Sewerage Digest

Effect of Stirring Scum

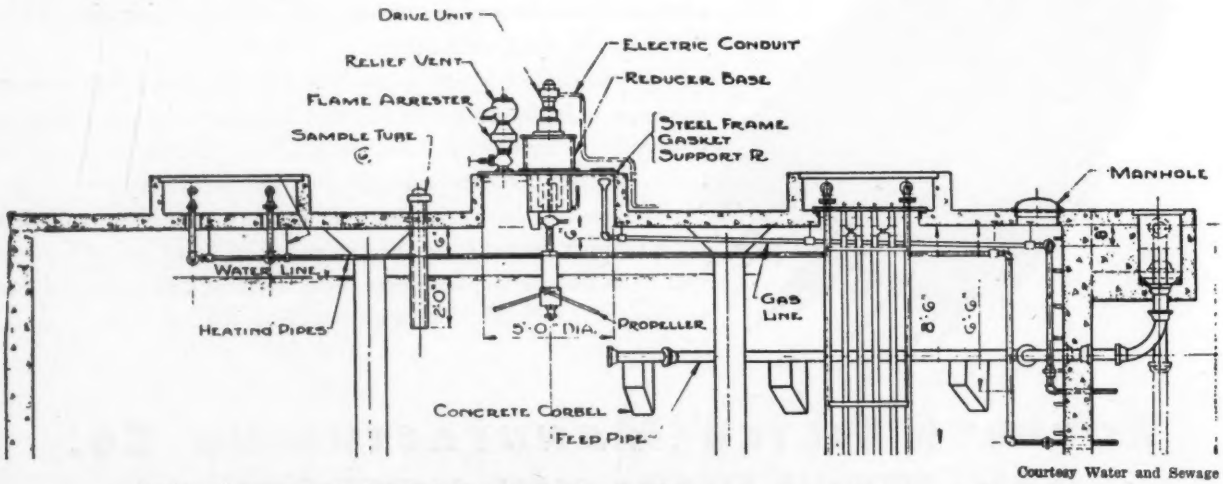
The treatment plant of Greater Winnipeg, Man., contains two digestion tanks equipped with Dorr turbo-mixers for primary digestion, and two others not so equipped intended for secondary digesters. When war loads increased, all four were used as primary digesters, and the sludge was drawn directly into elutriation tanks, serving as secondary digesters. This gave an opportunity to compare the scum which formed in these tanks from the mixed and the unmixed primary tanks.

The scum weighs from 50 to 53.5 lb. per cu. ft. It consists of particles which are supported by gas bubbles and of which some 99.9 per cent will sink if freed from the supporting gas bubbles. Usually only a small portion of the scum particles are longer than 1/8 in. It was found that the digester scum can be settled by stirring by Dorr turbo-mixers or by sprays. When ground to pass a No. 30 standard mesh sieve and be held on a No. 10, it will digest in the same way as other raw sludge.

The scum on the two digesters equipped with Dorr turbo-mixers never gives trouble as long as the raw sludge solids and temperature are controlled. The scum on the two digesters not yet equipped with stirrers accumulates to depths of 8 to 14 ft. so that this must be removed about once a year. The removal is a dangerous and costly work. Turbo-mixers permit 20 to 25 per cent additional raw-sludge solids to be put into a digester. By installing turbo-mixers in the two digesters which now give the digestion capacity of one digester only, the digester capacity of the plant can be increased one digester. [M11]

Catchbasin Cleaning in Newark

Newark, N. J., has 7,347 catchbasins, which it cleans twice a year—some of them oftener. For this it uses two Elgin "Eductors" and two cranes with orange-peel buckets, one a Healy bucket and the other a Hayward. Engineer Baver says the Eductor is clean and easy to operate, but is inconvenient for cleaning deep basins (some of Newark's are 40 ft. deep), does not remove bottles, tin cans, etc. and the entire unit must go to the dumping area to deposit the dirt. On the other hand, the crane can be used to raise the catchbasin grating and can drop the bucket to any depth, and can operate continuously loading a number of trucks. [J4]



Courtesy Water and Sewage

Section of upper part of typical digester showing installation of a Dorr turbo-mixer at the top to produce settlement of the scum.

Repairing Defective Sewer Joints

Evergreen Park, Ill., in 1937 laid a 42" reinforced concrete pipe sanitary sewer with its invert about 19 ft. below the ground surface, in supersaturated silty sand, by WPA labor. Some time later it was found to be leaking badly and 1220 ft. was dewatered and inspected. The infiltration of this length was found to be about 250 gpm. In nearly every joint there was no mortar in the lower half; in some a cold chisel could be passed between the spigot and socket. There was 8" to 18" of sand in the invert. Exterior repairs would be very expensive, so the joints were repaired from the inside.

A dam was placed in a manhole at the upstream end of the operation and the sewage was pumped from behind the dam, flowed over the surface, and reentered the sewer below the operation; and auxiliary pumps at intermediate manholes removed infiltration. At joints where no sand or water was entering under pressure, old joint material was raked out and the faces cleaned with muriatic acid. The upper ¾ of the joint was sealed with a mortar composed of 1 sand, 2 portland cement, 1 "Metalox," and a 10% solution of "Anti-hydro" cement in water. The bottom quarter was sealed with 1 "Metalox," 2 portland cement, and "Anti-hydro" instead of water. Where water was entering, small amounts of portland cement mixed with "Anti-hydro" were clapped to the joint and set in a few seconds; in some cases preceded by caulking with lead wool. This made the sewer practically tight. The cost was $8.195 per lineal foot, of which $1.595 was for cleaning, $2.35 for dewatering, overhead and contractor's profit, $0.41 for engineering and inspection, and $3.84 for actual repairs. [J8]

Scum in Digestion Tanks

Several engineers discussing the article Digest number E1, considered especially the problem of scum. Buswell believed that pumping liquor from below the scum onto the top of it continuously for 10 days or so will disintegrate it; and that circulation of tank contents for 5 or 10 minutes every day will prevent scum formation; with which Taylor agrees. Hazen cited an instance where drawing off the bottom of the digester contents and superimposing upon the top of the hard scum about a foot of fresh sludge and then 3 or 4 ft. of well digested sludge submerged the scum, which then was digested normally.

The providing of means for withdrawing floating sludge, which was suggested in the original article, was considered unnecessary by Buswell, especially as the removal of such dense material without actual shoveling would be difficult. But Taylor defended the suggestion by stating that some industrial wastes contain indigestible floating matter that should be removed from the tank; and that such withdrawal facilities permit large-scale testing of the character of top sludge. [E2]

Suggestions From South Africa

The sewage of Germiston and Boksburg, South Africa, is treated in a 5 mgd plant at Rondebult, which is 11 miles from each city. During this long flow the sewage becomes septic and the 36" concrete pipe lines began suffering by corrosion by sulphuretted hydrogen until ventilation was provided. Perforated manhole covers were inadequate for this, but stacks to create up-draft, provided at frequent intervals, proved effective. To prevent silt entering the manhole covers in the non-urban sections of the sewer, the manholes were carried 2 ft. above ground level. The covers had to be bolted to the shafts to prevent theft for sale as metal.

A venturi flume in the outfall sewer from each city measures the flow and transmits the record electrically through an armored cable to the disposal works, where it is recorded. This gives the operators about 1¾ hours' warning of the approach of any sudden variation in sewage flow. Lightning occasionally strikes this cable and disrupts this service.

At the plant are manually raked screens and [illegible] grit channels, which are

That's a lot of capacity—an all-welded-panel gas holder more than 1,000 feet high!

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There are good reasons for this overwhelming customer endorsement; Stacey Brothers pioneered the all-welded type of construction. Measuring capacity with "know-how", this 60,000,000 cubic feet of construction represents a wealth of experience—experience that pays off in speedier erection and trouble-free operation.

But there are other important advantages, too—inherent design features. The famous patented Stacey Brothers All-Welded-Panel construction not only licks the problem of internal corrosion behind vertical legs and between laps, but results in a structure that's mechanically round and free of unsightly deformations.

When you need gas-holder capacity, it will pay you to get a quotation and recommendations from Stacey Brothers. No obligation, of course. May we hear from you?

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cleaned by hand. There are 5 sedimentation tanks, and to insure equal distribution to these from the feed channel, the 5 tanks are located symmetrically about a central point, to which the screened sewage is brought and from which all the tanks are fed through radiating pipe lines, all identical in physical characteristics. This not only gives equal distribution at all rates of flow, but avoids the use of reticulation feed channels with low rates of flow, which cause deposit of solids. The 8 biological filters also are arranged symmetrically about a distribution tower and can be fed in any order desired, singly or by groups, and at rates adjustable for individual filters between limits of 205 and 1250 gpm. The filters are built and operated by a patented Dekema process, having 14 ft. depth of filter stone, through which air is blown downward, the whole enclosed in an air-tight structure. [X1]

Unusual Operation Of an Activated Plant

In operating three activated sludge plants with mechanical aeration at Florida army camps, where alkaline well water was used, the author followed directions but found that every peak load of soapy, alkaline water resulted in a grayish, non-settling and completely unhealthy mixed liquor. Algae grew rapidly on the galvanized splash plates and the operators were kept busy removing it. The remark of an operator that "every time I clean up this place, trouble starts" suggested the unorthodox procedure of *not* cleaning the slime from the aerators, which proved to be the solution. Apparently the slime they had been removing was really a culture of algae and bacterial slime which, left in the plant, performed an essential part in the oxidation. Now this slime is left permanently where nature places it. Influent with a pH up to 8.6 entered the aerator, but the effluent invariably had a pH of 7.3. To aid in the pH reduction, addition of CO_2 seemed desirable, and this they effected by not removing sludge from the primary tank. Apparently acidifying bacteria in the sludge produce CO_2 gas, which bubbles up through the liquid, utilizing oxygen present in the raw influent; and before anaerobes develop, the sludge floats as scum and is skimmed off before it can settle again, and is pumped to the digesters. If a particle of digester supernatent reaches the primary tank "you will really have an awful mess." This might not work in every plant, but in the ones referred to here the BOD is consistently below 1 ppm. [G6]

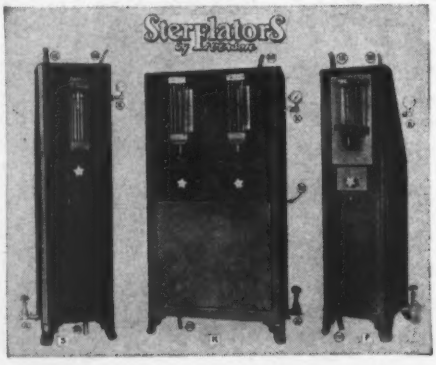
Sludge Treatment At the Blue Plains Plant

At the Blue Plains plant at Washington, D. C., sludge and scum from the sedimentation tanks are treated by digestion, elutriation, and dewatering by vacuum filters. Sludge gas produced totaled 252,300,000 cu. ft. in 1945. Methane gas content varied from 59.8% to 66.2%, and CO_2 from 31.0% to 35.5%. The net heating value of the sludge gas averaged 603.7 Btu per cu. ft. Of the volatile solids, 72.9% was destroyed by digestion. Sludge gas production was 11.0 cu. ft. per pound of volatile matter added to the digesters, or 15.1 cu. ft. per pound of that destroyed.

All digested sludge was elutriated by counter-current elutriation prior to conditioning for dewatering. The overall wash water ratio was one volume of digested sludge to 1.5 volumes of wash water. The effective reduction based on alkalinity decrease was one volume of digested sludge to 2.5 volumes of wash water. [H23]

Reconverting An Old Plant

Duncan, Oklahoma, has two Imhoff tank-sprinkling filter plants of 0.1 mgd and 0.5 mgd capacity built in 1922. These capacities have been outgrown and it is proposed to concentrate all sewage at the west side plant, pumping sewage there from the east side plant, the secondary tank there being converted into a pumping station. In the new plant, one side of the old circular Imhoff tank will be converted into an aeration agitator, the other side into a flocculator. Effluents from the old trickling filter and a new one will discharge



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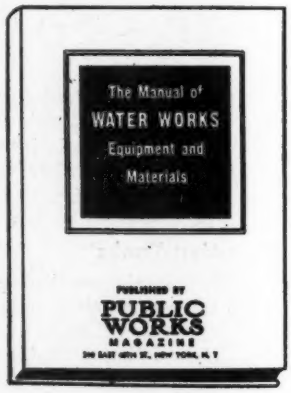

A great help in working up plans for sewage disposal

This Manual describes every type of equipment and material available for use in sewage disposal and sewer construction. Used by leading Sanitary Engineers everywhere when preparing plans. It is the standard source of unbiased information. If you don't have a copy of the 1945 edition, write today for information on how to obtain one.

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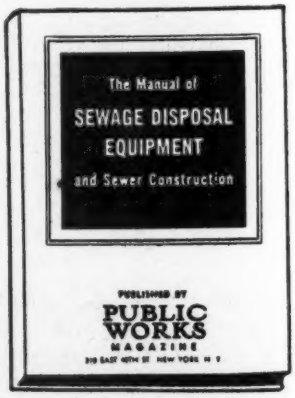
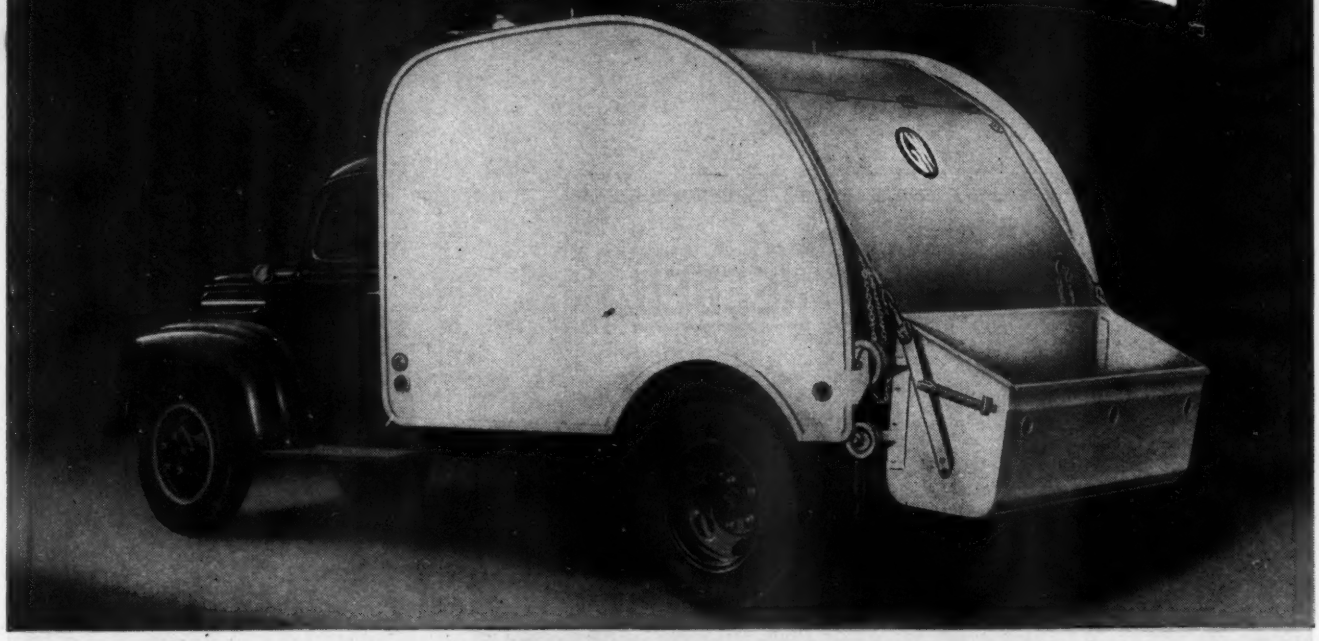
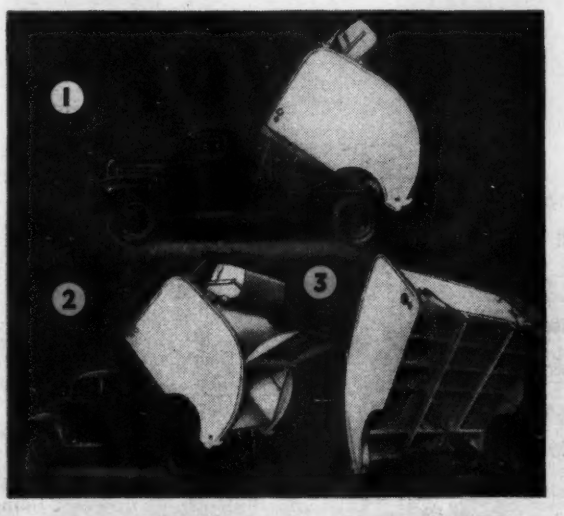


Presenting the

GAR WOOD *Bucket Loader*



THE NEWEST in SANITARY REFUSE COLLECTORS



1 As body is raised, loaded bucket travels simultaneously to top of body—hatch cover automatically opens and closes. 2 With body elevated to 50° and tailgate opened, the load slides free. Easily kept clean. 3 Solid, welded steel body understructure. Hydraulic hoist and cable mechanism.

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into the present secondary tank, which will be converted into a pumping station, pumping it into the present Imhoff tank to be used as a secondary tank. The old secondary tank will be converted into a sludge pumping plant. New structures will include grit removal chambers, comminutor, chemical building, Parshall flume, primary clarifier, trickling filter, sludge digester and sludge drying beds. H15

Bibliography of Sewerage Literature

D *The Surveyor*
February 22

13. Sewerage and Sewage Disposal in 1945. Pp. 141-146.
14. Theory and Operation of Separate Sludge Digestion Units. By L. L. Langford. Pp. 151-152.

E *Engineering News-Record*
February 21

2. Lessons From a Sludge Tank Explosion. Discussion of E1. By A. M. Buswell, Richard Hazen, S. P. Leclercq, William J. Wenzel and Henry W. Taylor. Pp. 77-79.

G *Water and Sewage Works*
January

4. Fine Screen Filters for Sewage Treatment. By G. Maclean Gardner. Pp. 31-34.
5. High-Capacity Trickling Filters. By J. A. Montgomery. Pp. 35-41.
6. Operating Activated Sludge Plants in Florida. By Chas. H. Carothers. Pp. 42-43.

H *Sewage Works Engineering*
February

11. One Quarter of Sewage Plants Need Modernization. Pp. 65-72.
12. Overloaded Akron Works to be Enlarged and Augmented. By Frank C. Tolles. Pp. 73-75.
13. Modernizing and Mechanizing the Marion, Ohio, Works. By Floyd Browne. Pp. 76-77, 130.
14. Major Plant Improvements at Garden City, N. Y. By Edward S. Ordway. Pp. 78-79.
15. Two Obsolete Works Replaced by Modernized Plant. By V. V. Long & Co. P. 80.
16. Septic Tanks and Contact Filters to be Replaced in New Plant. By G. C. Boyer. Pp. 82, 135.
17. Modernization and Rehabilitation in Elgin Sanitary District. By Kenneth V. Hill. Pp. 83, 131.
18. Elderly Sewage Plant Rejuvenated. By E. Sherman Chase. Pp. 84-85.

March

19. Design and Operation of Modern Incinerators. By Henry W. Taylor. Pp. 150-151, 170.
20. 1500 Sewage Works Projects Studied by Federal Works Agency. By Harry Hewes. Pp. 156-157.
21. Pulp Industry Studies Problem of Sulfite Liquor Recovery. P. 160.
22. Activated Sludge Improved by Dual Application of Chlorine. By N. Herda. P. 160.
23. Sludge Treatment at Blue Plains. P. 161.

J *American City*
March

7. Flood-Induced Sewerage Improvements. Pp. 93-94.
8. Evergreen Park, Ill., Eliminates Excessive Sewer Infiltration. By Arthur H. Lewis, Jr. P. 104.

M *Water and Sewage*
February

11. Scum Accumulations in Sludge Digestion Tanks. By D. L. McLean. Pp. 17, 36.

P *Public Works*
March

18. Cleaning a Digester. By Geo. A. Carpenter. Pp. 19, 32.
19. Methods Used by Cities for Disposal of Sewage Sludge. Pp. 29-30, 34.
20. Foam Phase Treatment of Sulphite Liquor. P. 31.
21. Activated Silica for Treating Paper Mill Waste. P. 36.

X *South African Municipal Magazine*
December

1. The Germiston Sewage Disposal Works. By G. B. Dersley. Pp. 23, 25, 27, 33.

Y *Contractors Record*
February 13

2. High-Rate Filtration. Pp. 393-394.

New Jersey Sewerage Projects

Projects approved for the construction of water supply and sewerage systems and treatment plants will be issued monthly by the New Jersey State Department of Health if sufficient requests are received to justify such publication. Write Dr. J. Lynn Mahaffey, State Dep't of Health, Trenton, N. J.

Allegheny County Sanitary Commission

The Board of Commissioners for the County of Allegheny at Pittsburgh, Pa., has announced the appointment of a five-member Board to constitute the Allegheny County Sanitary Authority which will plan and maintain a coordinated scheme of sewage disposal and treatment works for the 126 municipalities in the County, including the City of Pittsburgh. Colonel John F. Laboon, now Director of the County's Department of Works, recently returned from service overseas with the Allied Control Commission, has been named as Chairman of the Authority. Others on the board include Cornelius D. Scully, former Mayor of the City of Pittsburgh; David Olbun, Director of the County Bureau of Elections; Charles A. Finley, well known Engineer and William B. Rodgers, local businessman and member of the Chamber of Commerce. The Authority expects to begin func-

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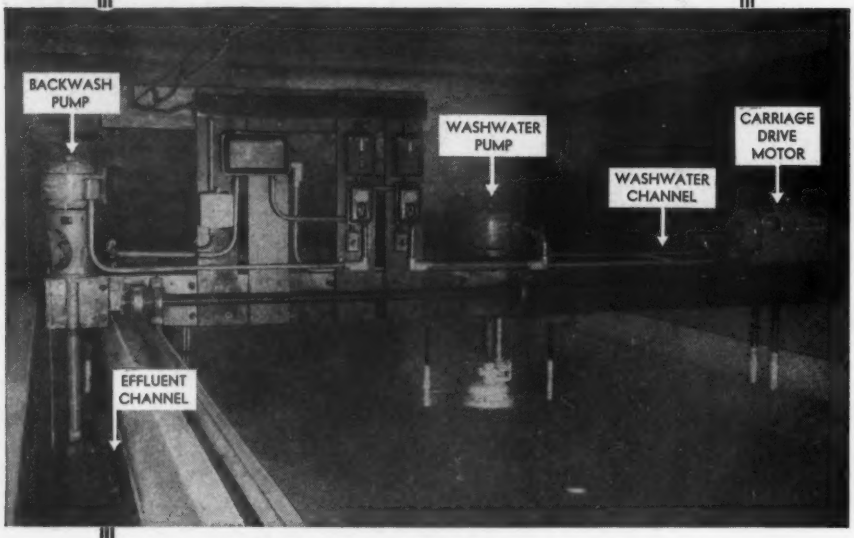

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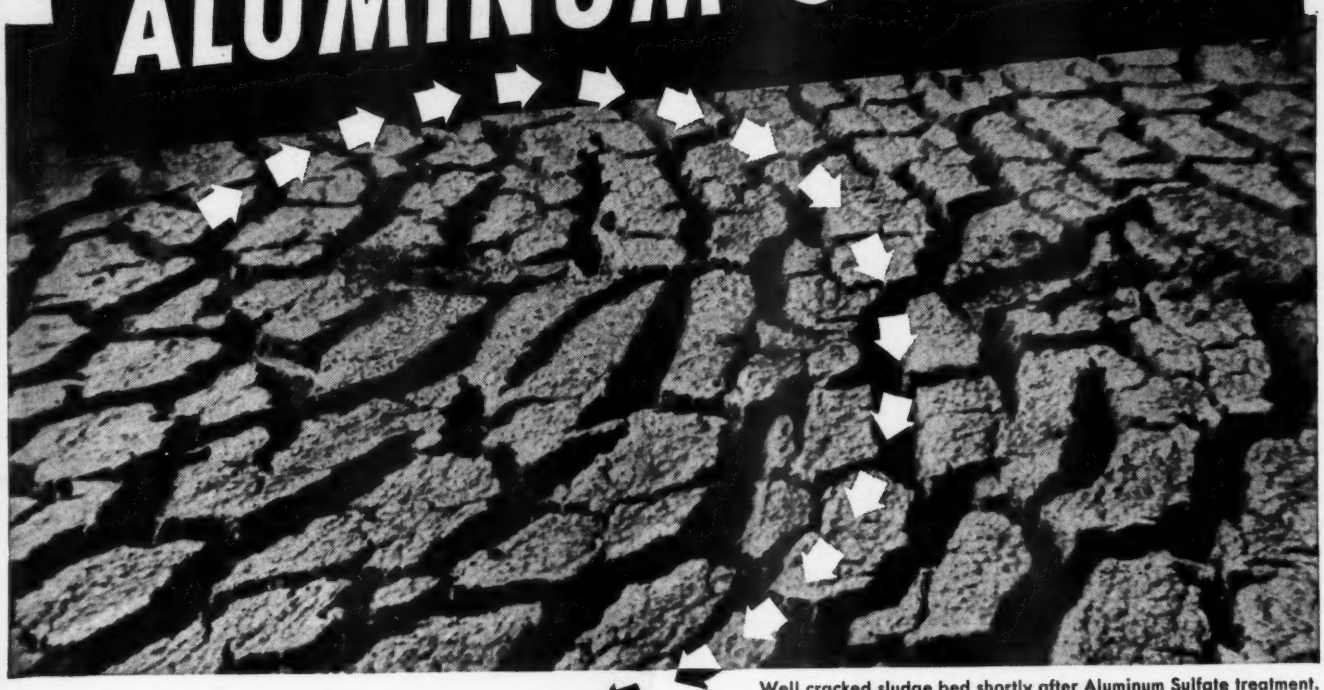

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In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

When you need special information—consult the classified READER'S SERVICE DEPT., *pages 79-81*

tioning shortly on work involving the preliminary surveys of vast sewerage net works and trade wastes within the County's boundaries.

Publications on City Problems

The Bureau of Urban Research, Princeton University, Princeton, N. J., extracts selected items from books, articles and periodicals reaching them. The following, which may be of value to cities, may be obtained as indicated below, or from the bureau otherwise.

Coordinated Public Works for Metropolitan Los Angeles, by G. W. Bemis, The John Randoph and Dora Haynes Foundation, Los Angeles, Calif., 1945, 24 pp., 10¢. It discusses the relations, among the several governments involved and among the projects, of problems in flood control, recreation, sewage disposal, highway, parks and shorelines. It recommends a new administrative agency to correlate these.

Comparison of Blighted and Good Areas in Los Angeles, City Planning Commissions, Los Angeles, Calif., 1945, tabular. A study based on populations, municipal services rendered, and municipal income and expenditures.

Comprehensive City Plan, Greenville, O. Prepared by L. Segoe, City Planning Commission, Greenville, O., 1945, 98 pp., illus. Intended to serve as a plan in accomplishing the orderly, efficient, economical and attractive future development of this city, which had a population of 7745 in 1940. Remedies will be applied over several years.

Rebuilding our Communities, by Prof. Walter Gropius, Harvard University, Paul Theobald, 5 No. Wabash Ave., Chicago 2, Ill., 1946, 61 pp., illus., $1.75. Stresses the necessity for letting the human element become the dominant factor.

New Cities for Old—City Building in Terms of Space, Time and Money. Louis Justement, McGraw-Hill Book Co., N. Y., 1946, 232 pp., charts, plates, $4.50. Discusses the problems of economics, politics, administration, finance, and design.

The Art of Building Cities. Camillo Sitte, translated by C. T. Stewart, Reinhold Publishing Co., N. Y., First published in 1889; republished 1945, 128 pp., illus., $5.50. The first English translation of a standard work. This book and the one preceding it in this list are excellent or necessary background reading for engineers who may have responsibility for city planning or development.

Corrosion of Steels

Corrosion of Steels, a 16-page booklet, indicates how various commercial steels may reasonably be expected to resist the attack of atmospheric corrosion in particular. The summary, brought up to date by Dr. John Johnston, Director, Research Laboratory, United States Steel Corporation, includes only information now generally accepted as reliable. Copies may be secured upon request to any Carnegie-Illinois Steel Corporation office.

Prevention of undue corrosion of steels in service is not a single problem but comprises a multitude of problems, each of which must be investigated separately. The ordinary accelerated test is far from a trustworthy indicator of what will happen to the metal in any environment other than precisely that in the test itself and great caution must be exercised in interpreting the results.

Figure 1 in the booklet shows how the degree of resistance of an ordinary steel to atmospheric corrosion depends upon its copper content until the metal contains about 0.20-0.25 per cent copper. Comparative corrosion rates over a period of as much as eight years of a plain steel (0.04 per cent copper), a copper steel (0.20 per cent copper), and U.S.S. Corten in an industrial and a marine atmosphere are shown in Figures 2 and 3.

The most important item in obtaining good protection of metal by a paint, or by any coating, is not the precise composition of the metal, but the proper preparation of the metal surface before the coating is applied. A priming coat containing an inhibitive pigment such as red lead or a chromate is advantageous, but its use will not make up for lack of care in preparing the metal surface.

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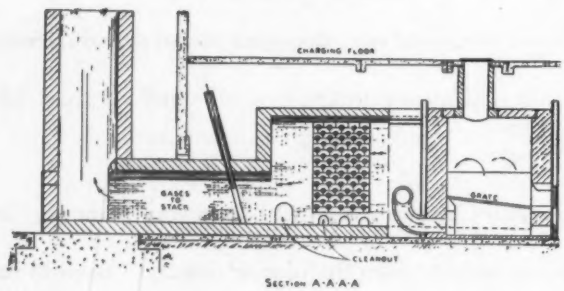

SECTION A-A-A-A

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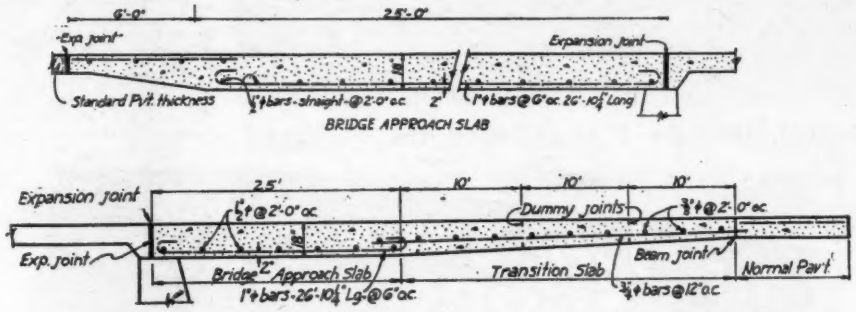
The Highway and Airport Digest

Design of Bridge Approach Slabs

Concrete pavement immediately behind bridge abutments often gives trouble due to settlement. The New Jersey State Highway Dept. has endeavored to eliminate this by preventing settlement of the fill and improving the design of the approach slab. To effect the former, it now requires that all fill adjacent to abutments be placed and consolidated in layers; that embankments constructed prior to placing this fill terminate not less than 10 ft. from the abutment footing and be graded back from that point on a slope not steeper than 5:1, or flatter if necessary for efficient operation of trucks, distributing and consolidating equipment; and that, if the slope of the natural ground is steeper than this, it shall be graded back to a 5:1 slope.

The slab design formerly used changed from 18″ thickness to standard pavement thickness in 5 ft. (See illustration). The new design substitutes a gradual change in a 30 ft. length and provides dummy joints at 10 ft. intervals to provide flexibility.[N18]



Courtesy Roads & Streets

New Jersey's old and new designs of approach slabs: Above, previous design; lower, new design.

Toll Superhighways For Chicago, Ill.

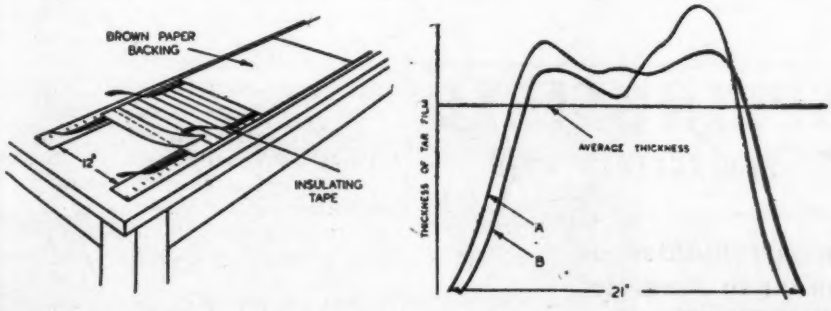
A report of the Illinois State Superhighway Commission discusses the idea of financing proposed superhighways by charging for their use, and found only one route which promised to be self-liquidating. The commission studied three cross-state routes and found one which promised to be 36.6% self-liquidating and two 11.8%. Of seven routes in the city of Chicago, toll was impracticable on four, and for the other three was estimated to be, respectively, 53.2%, 89.5% and 100% self-liquidating. The last would cost $51,600,000 for its 11.6 miles length. The other routes would cost $1,883,000 and $3,336,000 per mile, respectively. The average cost per mile of rural construction was estimated at $282,000 plus $18,000 for right of way.

"Toll projects must not have too much free competition, must have few access points, strategically located (toll) collection points and, of course, adequate revenues. As a rough rule of thumb, $50,000 in annual revenue is required for every million dollars of capitalization, excluding maintenance and operating costs." O17

Testing Tar Sprayer Performance

The British Road Research Laboratory has developed a method for testing the performance of tar sprayers, to determine the uniformity of distribution across the track of the sprayer. The test is made on the road itself during actual operation of the spreader, by spreading a "testing mat" on the road across the track of the sprayer. This mat consists of a number of strips of paper about 16″ long and 2″ wide, laid overlapping so that each strip exposes just 1″ of surface; and another strip of paper is laid along each edge of the mat so that the length of exposed area of each of the overlapping strips is just 12″; these edging strips being attached to the others by placing insulating tape between them, which permits easy removal of the strips after the test. The overlapping strips are numbered consecutively and each is weighed before being placed in the mat. After the sprayer has passed, the strips (each now having a 12″ x 1″ tarred area) are removed, folded so that no tarred surface is exposed, taken to the laboratory, and each weighed. Comparison of these weights with the original weights gives the amount of tar deposited on each transverse inch of pavement. (The unsprayed area of road covered by the testing mat is then tarred by hand).

To learn the reason for non-uniformity of coverage, a single spray jet is tested with a similar testing mat about 2 ft. long and its distribution curve plotted. If this is not symmetrical, the cause is investigated. If it is symmetrical, the spacing of the jets on the spray bar may be such that the peaks of one jet do not coincide with the hollows of the adjacent ones, as they should. Or the height of the spray bar above the road may not be that which gives the best results.[D8]



Courtesy The Surveyor

Distribution of tar from a single jet. Left, testing mat; right, A, symmetrical; B, unsymmetrical.

Joints in an Airfield Pavement

At Bunker Hill air station, near Peru, Ind., four runways 200 x 5,000 ft., two aprons 500 x 900 ft., and two taxiways 100 ft. wide were built in 1942, using 8″ concrete. The pavement was placed in strips 20 ft. wide with 1″ asphalt expansion joints spaced 120 ft. and contraction joints at 20 ft. intervals. No reinforcement was used. Contraction joints have opened as anticipated in the design and have been sealed with liquid asphalt. During the past three summers the asphalt expansion joint filler has extruded progressively and has been cut back four different times, using a steel sled provided with a cutting blade and a scarifier

tooth which cuts out the filler about ½" deep in the joint; the sled being drawn by a rubber-tired tractor.[E12]

Stabilization by The Lime Process

In constructing aerodrome runways and perimeter tracks on sandy areas in Great Britain, the "wet sand" or lime process has been used in some cases. This consists of adding hydrated lime to the damp sand, then adding an asphalt which has been thinned with a phenol solvent, which forms a soap with the lime and distributes the asphalt uniformly over the sand grains. When the solvent evaporates, the material firms up. Normally the amount of lime used is 2% of the dry sand, and of asphalt cutback 6 to 8% heated to 110° C. The sand mixture (prepared in stationary mixers or by a Barber-Greene continuous mixer) is spread in a 4" layer with a mechanical finisher and tamper.[Y9]

Job Evaluation in the Missouri Highway Department

"Salaries and wages paid by the Missouri State Highway Dept. are now based on a system of job evaluation and personnel merit rating that has been worked out through a period of painstaking study covering many months. We believe that we have succeeded in establishing a fair relationship between basic rates of pay for different jobs, according to the knowledge and experience required to meet the difficulty and responsibility of each job. We further believe that this personnel policy will enable the department to attract and retain better and more efficient employees, to the end that a better and more efficient highway system will be constructed and maintained at less cost to the highway user." In March, 1945, a personnel committee was appointed consisting of four bureau heads and a division engineer. This committee considered four basic systems: (1) the ranking system, (2) the classification system, (3) the point system, and (4) the factor comparison system, and decided to use a combination of the last two, using a measuring stick involving skill, effort, responsibility and job conditions. A questionnaire was sent to each employee to obtain his opinion of his job—what he did and why and how. Also each of the 10 division engineers reported on each job under his supervision. One, 2, 3 or 4-point values were allowed for each of several items under each of these headings for each job, and total comparative values for each job were thus obtained, with a maximum and a minimum value based upon the amount of training time required to comprehend completely all aspects of the job. The salary limits for each job were obtained by multiplying total points by $5. The individual salaries within these limits are based upon a merit rating covering 11 points, including amount and quality of work done, intelligence, versatility, judgment, etc., the rating of each employee being made by two of his immediate superiors and reviewed by the division engineers and bureau heads.[R6]

Cement-Treated Bituminous Base

Some Canadian roads resurfaced with 1" to 3" of plant-mix asphalt material have failed, presumably because the new surface prevented evaporation of the moisture present in a base containing a high percentage of material passing a 200-mesh sieve. To provide a better base, the plan has been tried of mixing cement with the existing material to form a base, on which was placed a plant-mix wearing surface composed of 180 lb. per sq. yd. of open-graded-mix base course and a 60 lb. dense-graded-mix surface course. The existing surface was scarified, rolled with a sheepsfoot roller, disked, turned with a blade, and pulverized with a mechanical mixer until all particles would pass a 1-in. sieve. This was respread and the road scarified to a depth to compact to 6"; then the material was windrowed, pulverized to break up lumps not previously treated. A distributor made a furrow in the top of the windrow and deposited cement there to equal 4% of the windrowed material. Sufficient water was added to give a content of approximately 11%, and the material was spread to the

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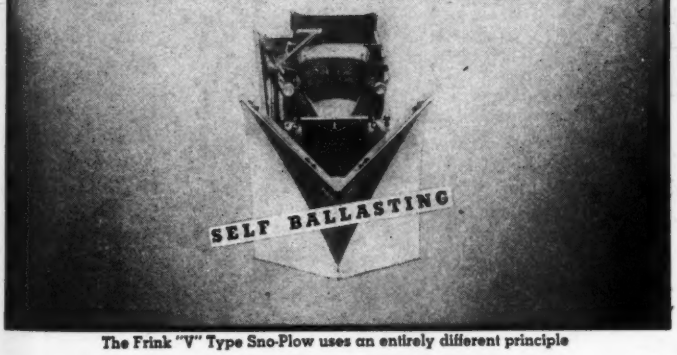

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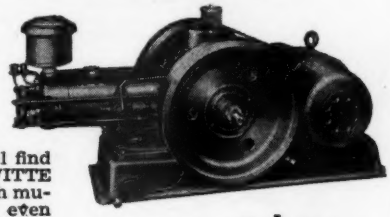

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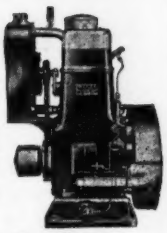

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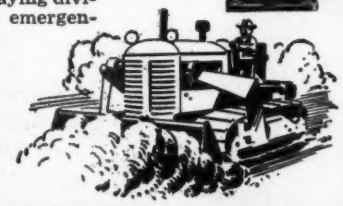

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proper thickness, and immediately compacted with a 12-ton 3-axle roller, and trimmed to grade with a motor grader, then rolled with a 2-axle pneumatic-tired roller, securing an average compaction of 97%, and immediately covered with an asphaltic emulsion curing seal. Later, transverse cracks appeared every 15 to 25 ft. Indications are that this base will prove to be satisfactory.[W8]

Soil Compaction

Soil compaction methods were discussed at a conference of 50 soils engineers and scientists held by the A. R. B. A. Some of the ideas brought out are given below:

"Compaction of subgrade often increases bearing capacity as much as 150%."

It is important to obtain maximum compaction, whatever the soil, and laboratory studies are needed as basis for promoting a program of field experimentation. The poorer the soil, the more rigid the specifications must be to obviate slides in fills. Contractors should be educated to cooperate in applying Proctor control.

The criterion of quality is not the density but the structure of the soil, including absorbed moisture film. Increased strengths were found where compaction was secured 2% to 3% on the dry side of optimum. Tendency was noted to overrate the importance of moisture control, instead of concentrating on getting compaction. CAA practice is to run 10 to 15 density tests daily on a 1,000 to 1,500 ft. runway section, staggering locations at different lifts. Another agency recommended a test for each 5,000 cu. yd. of loose material.[N15]

Earthwork in an Airport Grading Job

In a 9.5 million yard grading job at a West Virginia airport, eight 1½ to 2½ yd. shovels have averaged 1200 cu. yd. per 8 hr. day per shovel. Shovels have loaded to 12 yd. rear dumps, to bottom-dump trailers and to several 25-ton side dump 6-wheel trucks. About 12,000 cu. yd. per 8-hr. day was moved by twenty-one 12-15 yd. tractor-drawn scrapers, twelve 22-25 yd. tractor-drawn units, and six 16-yd. self-powered scrapers on 1500 to 1800 ft. hauls. Practically all drilling for blasting shale rock is done horizontally, holes at 15 ft. spacing being carried about 75 ft. into the ledge.[N16]

Highway Research In Kentucky

Work proposed to be done by the Highway Materials Research Laboratory of the Kentucky Highway Dept. has been divided into 6 major categories: Concrete and aggregates; bitumens and bituminous mixes; soils; and chemical, physical, and field observations. Others may be added later. A total of 21 research projects dealing with concrete and constitutent materials and 14 projects of investigating bituminous mixes and related pavements have been completed or are now in progress.

Other projects include chemical studies of paints and bituminous materials, with possibly microscopic and photographic methods. Chemical analyses of soils may show that chemical properties are often more important than voids, grain size, or structure.[N19]

Experiments With Dense Tar Carpet

Sheffield, England, has been manufacturing its own surface material since 1914. Between 1932 and 1939 the most successful material used was a mixture of limestone, ⅛ in. to dust, and asphalt having a penetration of 65 at 77° F, the binder content being 12½% by weight of the total material. In 1939 the city began experimenting with the use of tar as a binder, making a dense tar carpet. These experiments have been continued to date and have shown that a dense carpet can successfully be made with tar as the binder, and although it is too early to say that it possesses the stability and wearing properties of dense carpet using asphalt as a binder, the two materials certainly have many qualities in common. For example, both have proved themselves ideally suitable for the patching of carriageways and footpaths prior to surface dressing, and tar asphalt can be used with excellent results as a surfacing material for new footpaths, provided that the consolidated thickness is not more than 1 in.

Tar carpet can be used for surfacing roads carrying any but the heaviest

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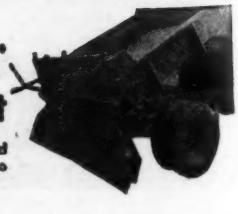

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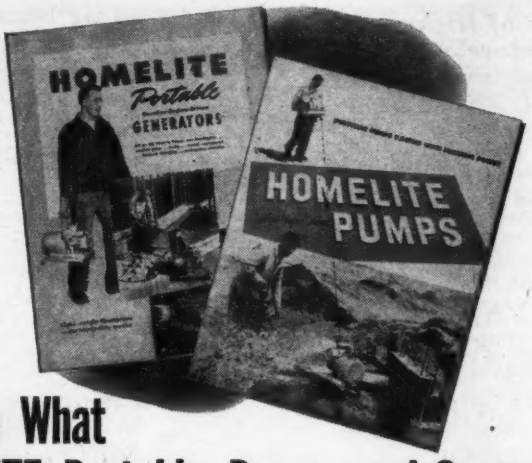

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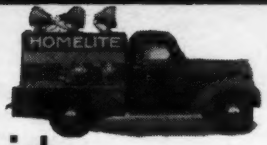

then see what they'll do on the job Homelite Representatives, now located in strategic centers throughout the country, are ready to give actual on-the-job demonstrations of Homelite pump and generator performance. Let them give one for you. Let them show you all the pumping qualities of Homelite Portable Pumps. Let them show you the new Homelite Portable Generators in action . . . running floodlights or all kinds of electric tools . . . on *your* job, any place, any time. Simply write.

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traffic, if laid to a consolidated thickness of not more than 1¼ in. (in most cases only 1 in. is needed), and can be feathered out to practically nothing, if so desired. The cost of manufacture is slightly over one-half the cost of asphalt carpet. It can be provided and laid as a surfacing material 1 in. thick, for approximately 2s. per sq. yd. (One shilling equals 20 cents.)

On footpaths where the traffic is only light, the consolidated thickness can be reduced to ½-in. thickness without fear of disintegration, and laid at a cost of a little over 1s. per sq. yd. This surface tarsprayed (after twelve months' wear), at an additional cost of 4d. per sq. yd., will give a perfectly sealed, safe and durable wearing surface with a long life free from maintenance.

The same principle of surfacing, followed at a later date by surface dressing, can equally be applied to carriageways, and for about 2s. 6d. per sq. yd., a perfectly sealed top coat with an ideal non-skid surface can be obtained.

In the writer's opinion, the success of the dense carpet depends largely on the grading of the aggregate, and in this respect the difficulty is to obtain a sufficient supply of fine aggregate with a consistent grading—the main essential in the grading being a minimum content of fines passing 200 mesh, amounting to 10 per cent of the whole mix.[D5]

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February 8

5. Experiments on the Use of Tar as a Binder in Dense Carpets. By John Miller. Pp. 99-101.
6. Site Preparation, Including Sub-Grading, and Drainage of Roads. Discussion of paper. Pp. 103-106.
7. Soil Mechanics and Road Foundations. By A. H. D. Markwick. Pp. 107-111.

February 22

8. Testing the Performance of Mechanical Tar Sprayers. By A. G. Tarrant. Pp. 139-140.

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February 21

11. The Pan-American Highway. By Maurice E. Gilmore. Pp. 64-69.
12. Durability of Concrete at an Airfield. Pp. 80-81.

March 7

13. Detroit Plans a 15-Year Airport Development. Pp. 88-90.

J *American City*
March

7. A Small Airport's Civic Responsibility. By Deane Seeger. Pp. 96-97.
8. Traffic Moves in Central Philadelphia. By Leonard A. Drake. Pp. 111-112, 125.

N *Roads and Streets*
January

15. Soil Compaction Conference Notes. Pp. 67-69.
16. 9.5 Million Yard Airport Grading Job. By Harold J. McKeever. Pp. 71-76.
17. Rebuild Engineering Manpower. By Charles M. Upham. Pp. 77-79, 94.
18. Bridge Approach Slab Design in New Jersey. By F. D. Woodruff. Pp. 82-83.
19. Highway Research in Kentucky. By L. E. Gregg. Pp. 86-88.
20. What Price Maintenance Cost Data. By E. L. Worthington. Pp. 90, 92, 94.
21. Soil Asphalt in Rebuilding and Widening Two Texas Roads. Pp. 96-97.
22. Improving Engineer-Contractor Relationships. By H. K. Glidden. Pp. 103-106.

O *Roads and Bridges*
February

14. City Traffic Engineering Activities. Pp. 60-61, 134.
15. Soil Sampling and Testing. By R. M. Hardy. Pp. 63-66, 113.
16. Examination and Testing of Concrete Materials. By L. A. Thorssen. Pp. 67, 102.
17. Economics of Toll Superhighways. Pp. 71-76, 94.

P *Public Works*
March

15. Highways and Airports as Malaria and Mosquito Producers. Pp. 20-21.
16. Essentials in Producing Plant-Mix Stabilized Material. P. 24.
17. Airport Planning and Design Factors. By W. E. Cullinan, Jr. Pp. 27-28.
18. Two-Way Radio Saves Money on Snow Removal. P. 31.

S *Construction Methods*
February

2. Ohio Resurfaces Old Pavement With Bituminous Concrete. By C. R. Hanes. Pp. 100-101.

U *Public Roads*
January-February-March

3. Joints and Cracks in Concrete Pavements. By Earl C. Sutherland. Pp. 179-205.

W *California Highways and Public Works*
January-February

6. New Devices Aid in Maintenance Work. By Carl F. Lind. Pp. 2-5, 28.
7. Bridge Maintenance Practice On California Highway System. By Merle E. Fischer. Pp. 23-28.
8. Modified Cement Treated Base Experiment. By J. W. Trask. Pp. 29-30.

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Z *Highways, Bridges and Aerodromes*
February 13

6. Site Preparation, Including Subgrading, and Drainage of Roads. By R. N. Law. Pp. 4, 6, 8, 16.

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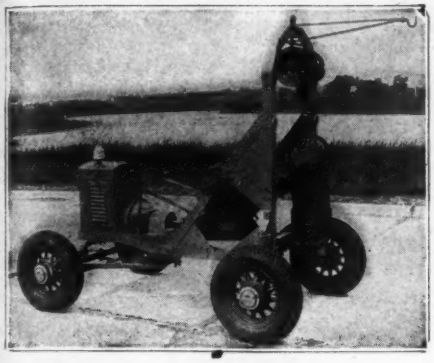

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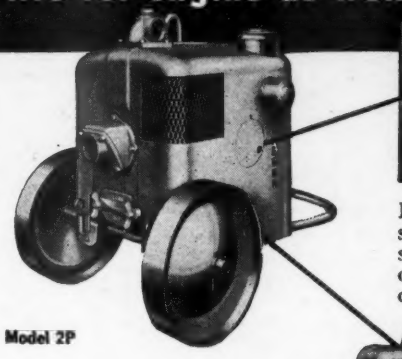

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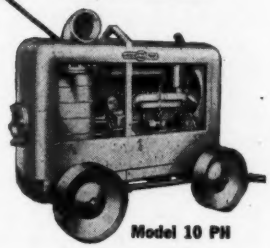

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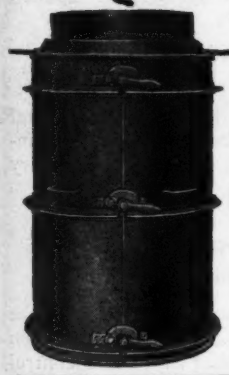

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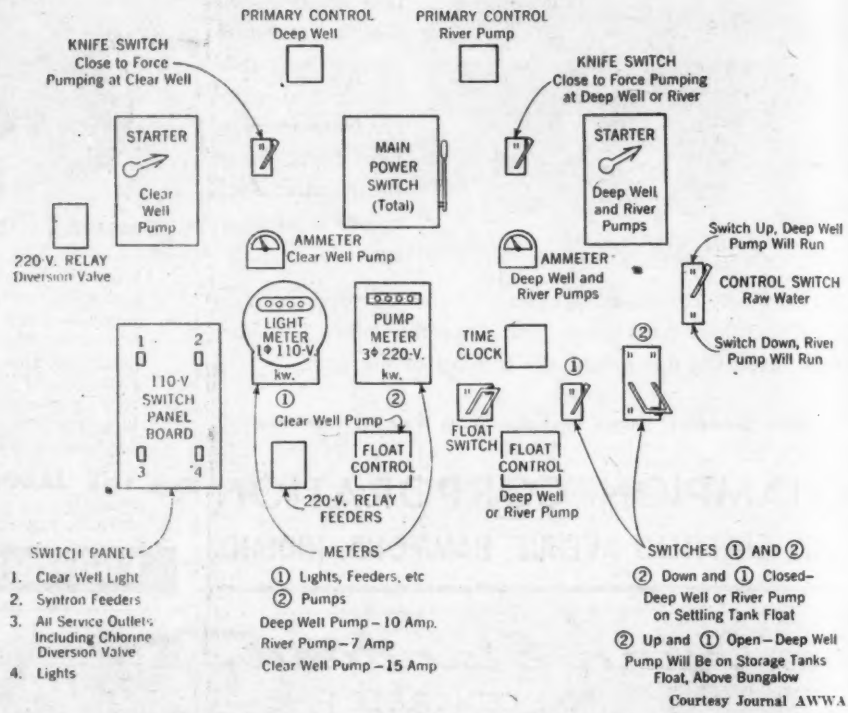
The Waterworks Digest

Water Softening At Miami, Florida

A 10 mgd softening plant for Miami's water supply was built in 1925, increased successively to 20 mgd and 40 mgd, and a 60 mgd plant is now under construction, contracts having been let in August, 1945, for most of the major equipment. In addition to having increased capacity, the new plant will further reduce the color, a 10 gpm pilot plant having tested various methods of effecting this, including double treatment with lime, high alum dosage, ozone, sodium silicate and break-point chlorination. Several Florida softening plants use sodium silicate for its excellent flocking ability, but it was found that it does not remove color. Break-point chlorination has been adopted for removing the last 10 to 15 ppm of color.

In the new plant, the raw water will pass through 2 Venturi meters, which give automatic control of lime and soda ash feed, and 2 sand traps, to flash-mix tanks and flocculators, and then to 3 clarifiers. Clarified effluent will be recarbonated in a basin, the influent and effluent of which will be constantly checked by a Bristol pH recorder, which will automatically maintain the effluent pH between 7.5 and 7.8. Then chlorine will be added at the rate of about 75 lb. per mg (established as the break-point dose for Miami's water) by automatic control, with at least ½ hr. detention in a contact basin. From the contact basin the water will pass to aerating basins, where filtered air agitation will remove excess CO_2 and nitrogen tri-chloride. Effluent from the aerating basins will be brought to a pH of about 8.3 by adding caustic soda, and passed onto the existing rapid sand filters, to be operated at 3 gpm per sq. ft. instead of 2, as formerly, thus avoiding the necessity of increasing the filter area.

A plant to calcine calcium carbonate sludge into quicklime will be built, consisting of a slurry mix tank, sludge thickener tanks, a centrifuge for dewatering the sludge to approximately 35% moisture, a rotary kiln, oil firing equipment, a lime cooling unit, conveyor, elevator and storage silo. At the rated capacity of 80 tons of lime a day, about 115 tons of CO_2 gas will be discharged, of which 9 tons will be used for recarbonating the water, and several private interests offer to buy the remainder for producing liquid carbonic, dry ice and other uses.[A41]

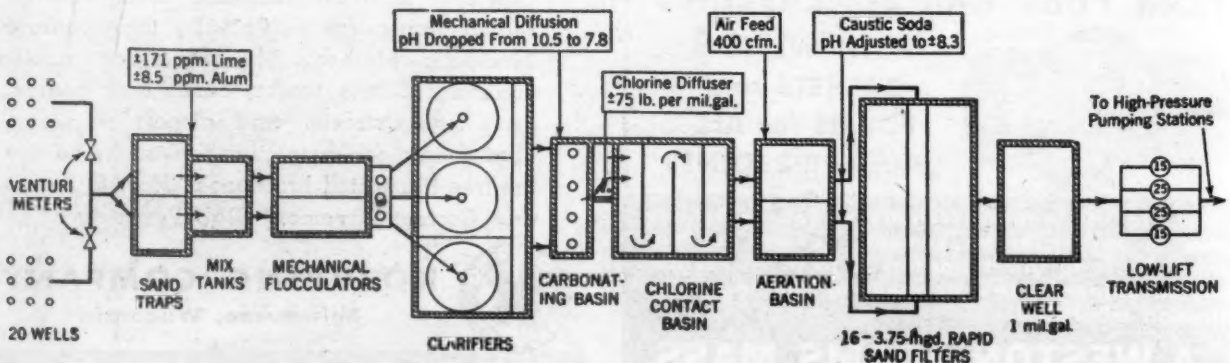

PRIMARY CONTROL Deep Well
PRIMARY CONTROL River Pump
KNIFE SWITCH Close to Force Pumping at Clear Well
KNIFE SWITCH Close to Force Pumping at Deep Well or River
STARTER Clear Well Pump
MAIN POWER SWITCH (Total)
STARTER Deep Well and River Pumps
220-V. RELAY Diversion Valve
AMMETER Clear Well Pump
AMMETER Deep Well and River Pumps
Switch Up, Deep Well Pump Will Run
CONTROL SWITCH Raw Water
Switch Down, River Pump Will Run
LIGHT METER 1φ 110-V. kw.
PUMP METER 3φ 220-V. kw.
TIME CLOCK
110-V SWITCH PANEL BOARD
Clear Well Pump
FLOAT SWITCH
FLOAT CONTROL
FLOAT CONTROL Deep Well or River Pump
220-V. RELAY FEEDERS
SWITCH PANEL
METERS
SWITCHES ① AND ②
1. Clear Well Light
2. Syntron Feeders
3. All Service Outlets Including Chlorine Diversion Valve
4. Lights
① Lights, Feeders, etc
② Pumps
Deep Well Pump – 10 Amp.
River Pump – 7 Amp
Clear Well Pump – 15 Amp
② Down and ① Closed – Deep Well or River Pump on Settling Tank Float
② Up and ① Open – Deep Well Pump Will Be on Storage Tanks Float, Above Bungalow

Courtesy Journal AWWA

Electrical control panel in filter plant, Sharples, W. Va.

Automatic Operation Of a Small Filter Plant

Six months of actual operation of the Sharpless, W. Va., 100 gpm filtration plant has shown that automatic control of a small filtration plant from intake to storage is practicable for reducing the operational attendance cost to a



Courtesy Journal AWWA

Flow diagram of proposed 60-mgd. water softening plant at Miami, Fla.

Original Woodcut by Lynd Ward

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minimum, and this reduced cost more than compensates for the installation cost of such control.

This plant supplies water to three mine camps, each with its own elevated storage tank. The primary source is a river, water from which passes through a desilting tank and is pumped to a settling tank. A deepwell supply, used as a secondary source, is pumped to the settling tank. From the settling tank the water flows by gravity to filters, thence to a clear well, from which it is pumped to the several storage tanks. Wash water is supplied by gravity from the nearest storage tank, the rate being maintained at 375 gpm by passing it through an orifice plate. Coagulating chemicals (lime and alum) are applied by dry feeders, at rates automatically controlled by the raw water intake pump. Calgon is added in the clear well. To keep both well and well pump in operating condition, the latter is operated automatically about 1 hr. each day by means of two magnetic switch controls and a time switch control, which transfers power from the stream pump to the well pump at 9:30 A.M. each day. The normal operating cycle is controlled by two level-control switches—a float-type switch in one of the storage tanks wired to the clear well pump starter circuit; and an electrode-type switch in the settling tank, wired to the river and well pump starter circuit.

With all equipment idle, when water in the storage tank falls below the bottom setting of the float switch, this starts the clear well pump and flow of chlorine to the clear well. As the clear well water level falls, water passes through the filters from the settling tank; and fall of level here below the bottom electrode starts the intake pump, and at the same time the chemical feeders are started by means of a relay. When the storage tank has filled to the top setting of the float switch, the clear well pump stops and the chlorine flow is changed to the settling tank. Flow from the settling tank through the filters to the clear well continues until all three are at the level of the top electrode setting in the settling tank, when the intake pump stops.

All the control boxes are mounted on a panel board located in the filter plant, which also contains meters and switches as shown in the accompanying illustration.[A45]

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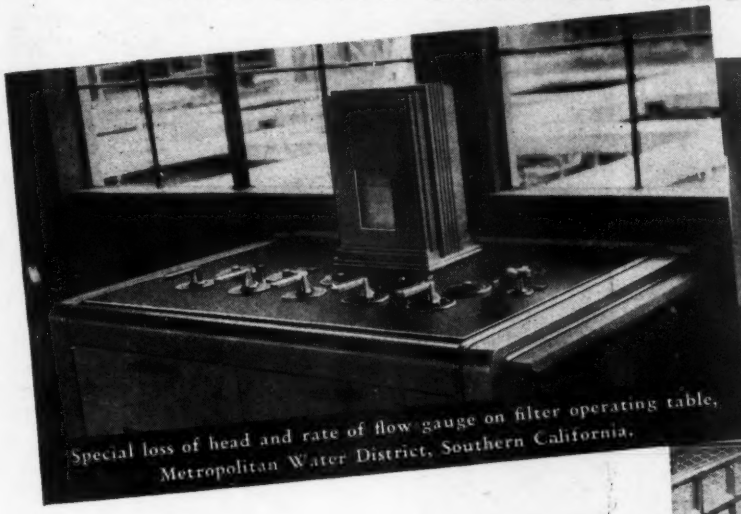
Residual Chlorine Recorders in Chicago

At Chicago's South District filtration plant two risidual chlorine recorders are in use, one having its electrode located near the outlet of the filtered water reservoir and measuring the residual chlorine in the water as it leaves the plant. The other has its electrode connected to one of the mixing basins, and as soon as they can be obtained, 3 more will be placed on mixing basins to record residual chlorine immediately after chlorine application. Two other machines will record the residual in the filtered water header and 2 others in the main filtered water reservoirs.[F21]

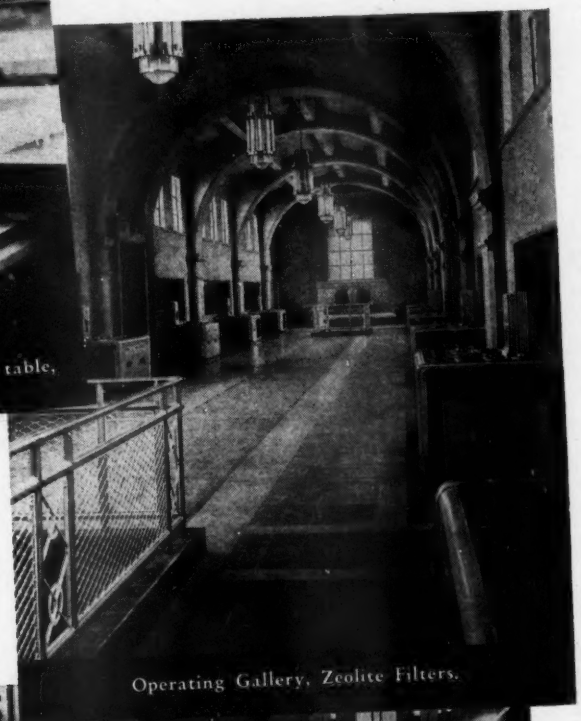
Softening At Alliance, O.

In connection with a comprehensive improvement program, Alliance is installing a softening plant, contract for which was let in January 1946 for $192,962. Operation will be on a split treatment basis; 75% of the raw water will be over-treated with lime to remove most of the magnesium hydroxide, settled, and the effluent mixed with 25% raw water and stabilized and settled. Part of this will be passed through 8 rapid sand filters, and part through greensand zeolite filters, the relative amounts being such that a mixture of the two will contain approximately 85 ppm hardness. It is expected to obtain the salt for the regeneration of the zeolite from a brine well which will be drilled near the chemical building. All available information points to the fact that an adequate supply of brine, containing about 0.5 of a pound of salt per gallon, will be reached at a depth of 600 feet. This brine will be pumped to the chemical building, iron and barium removed, and then filtered. Provision will also be made for the delivery of salt by truck.[F19]

OF A LONG LINE OF THOROUGHBREDS



Special loss of head and rate of flow gauge on filter operating table, Metropolitan Water District, Southern California.



Operating Gallery, Zeolite Filters.

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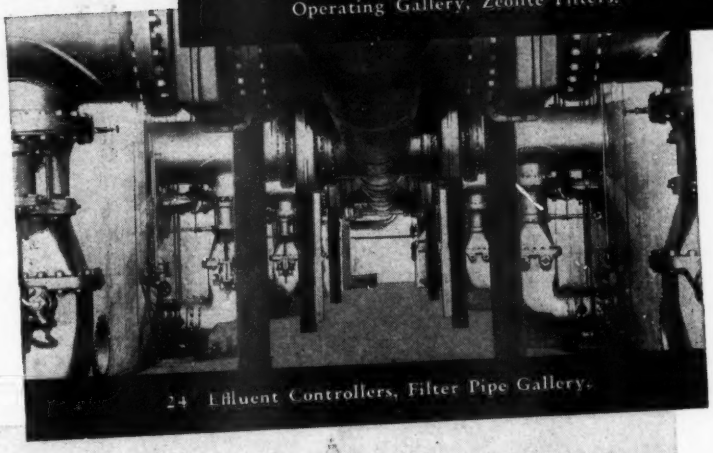

24 Effluent Controllers, Filter Pipe Gallery.

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Metropolitan Water District of Southern California Water Softening and Filtration Plant.

Photos courtesy Metropolitan Water District

Grouting Leaks In a Dam Foundation

Watertown, N. Y., takes its supply from Black River, at a point where a large island divides it into two branches. Two dams constructed across one of these branches form a settling basin of 60 mg capacity. Alum is fed to the river water entering this basin through a 42" sluice gate in the upper dam. The basin is normally emptied and cleaned once in three years, using a 5 mg pump for eight or ten hours. But in April, 1945, when an effort was made to empty the basin, water leaked under the upper dam through crevices in the limestone river bed at such a rate that it was impossible to keep it empty. A contractor undertook to fill the cracks, and two rows of holes were drilled 3 ft. deep in rock below the dam, one row paralleling and 1 ft. from the bottom of the dam, the other 3 ft. from it, spaced 5 ft. apart in the row. In each hole a length of 1½" pipe was placed vertically and calked with lead. A sand-cement water mixture was forced into the pipes by use of a cement gun, but the air carried the material out of the crevices into the river and even made new openings. A Koehring mud jack had just been received by the Dept. of Public Works for raising sunken sidewalk slabs, and by use of this a mixture of equal parts of sand, sandy loam and cement was pumped into the pipes. This filled the crevices until a pressure of 100 to 120 lb. could be applied. Usually 2 to 3 cu. ft. of the mixture to a pipe sufficed, but in a few cases when no pressure was built up, this amount was allowed to set for three days when further pumping successfully plugged the hole. It seems reasonably certain that all leaks have been stopped. [F12]

Soil Studies for San Jacinto Dam

In preparing to design a dam 9,000 ft. long, of which 7,700 will be embankment and 1300 ft. spillway, the foundation was investigated. Identification cores 2¾ in. in diameter were taken to an elevation of — 160 (ground surface averaged about + 20) along the center line and 1,000 ft. up stream and down stream. Then 6" cores were secured from selected elevations for consolidometer tests. Five open pits were put down to a depth of 18 to 20 ft. to investigate the topsoil, samples being secured for making permeability, density and grading tests. Permeability tests were taken on samples secured in both vertical and horizontal directions. Then coring was started to secure unconfined compression test samples, 2¾ in. holes being located at intervals of 200 ft. along the center line of the dam; these tests being made to determine approximately the cohesive strength of the clay strata, the location of the clay, and a detailed foundation profile. When the open pits were dug, large undisturbed samples were secured from the top of the clay strata for erosion studies. [L4]

Free Eels for Water Consumers

At Kittery, Maine, for some years eels have been found in house service corporations and in screens of large meters and chlorinating machines. These eels were blind, and apparently old residents of the mains. But in 1945 many that were not blind were found and it was discovered that new ones were getting through the screens at the intake. It was decided to place strainers in the two 12" supply mains near town where the strainers could be cleaned about once a week. Each 12" line was bifurcated for a few feet and a strainer was placed on each branch. These strainers remove debris besides eels. especially during the fall turnover. Eels removed in cleaning the strainers are given to residents for food.

The strainers installed are multi-duct manufactured by Blackburn-Smith, each containing 3 baskets, 2 of which are in operation at all times; each basket being 12" x 12" and containing 3/16 in. circular openings, the total area of which in each basket is about 1½ times the area of the 12" pipe. While one basket is being cleaned the other two remain in service. A pressure gauge is

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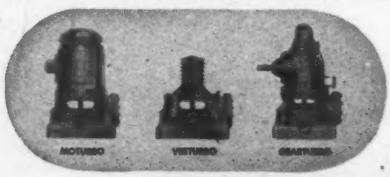

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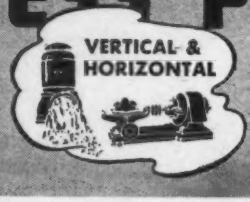

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placed on each side of each strainer, and if the drop pressure through the strainer is 2 lb. or more, the strainer is cleaned.[V5]

Joint Operation of Water and Electric Utilities

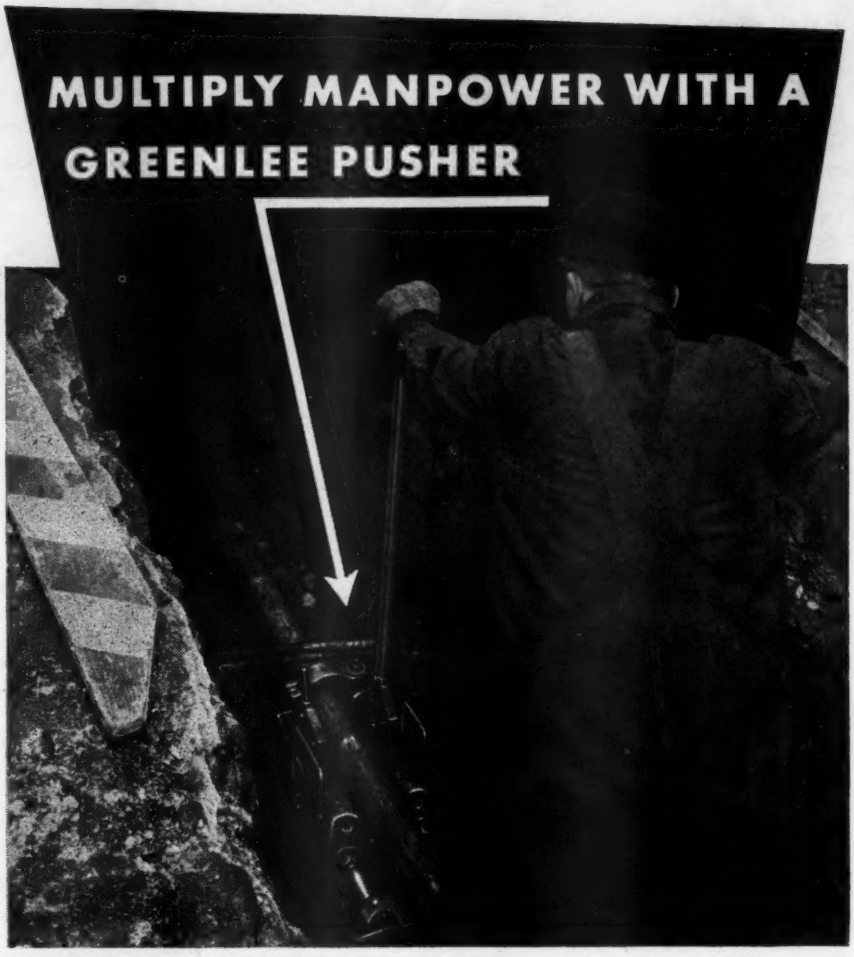
In Kalamazoo, Mich., the city operates both the electric and the water utility. The City Manager has reporting directly to him a water works superintendent, lighting plant superintendent, utilities accounts supervisor, and a construction superintendent who supervises construction in both utilities. About half the permanent employees work at one time or another for both utilities and each turns in a daily report which shows the distribution of his time between the two. Both electric and water meters are read by the same men. The trouble crew uses a truck supplied with facilities for emergency work for both utilities, including a detail map of both distribution systems, spare water and electric meters, etc., and the men are competent to handle both water and electric repairs.[A48]

Electric Cutting Of a Cast-Iron Pipe

The Akron, Ohio, water bureau found it necessary to repair a 36" cast-iron pipe which was found to have a crack 3 ft. long in the bottom, including the bell. The pipe was laid in rock and the broken bell directly under a gate house wall, which made the repair difficult. The method employed was to cut the pipe with an electric torch. First a hole was burned through the pipe at the end of the crack to prevent it from extending during the cutting. A circumferential cut was made in two passes with two cutters working continuously diametrically opposite each other. Then a longitudinal cut was made on the top of the pipe diametrically opposite the crack, and the two halves removed. The cut averaged ½ in. in width. Two truck-mounted generators with automatic voltage regulators were used to supply the current for the cutting torches. In cutting the pipe, 300 amp. were used. This was increased to 350 amp. when cutting the bell. About 31 lb. of "Fleetweld," 3/16-in. No. 5 coated rod were used for the 14 lin. ft. of cutting. Cutting was started at 11:30 P.M. and completed at 2:00 A.M., and the new length of pipe inserted and water passing through by 6:30 A.M.[A44]

The 1946 Drinking Water Standards

Heretofore, drinking water standards adopted by the U.S.P.H.S. have been designed to apply specifically to those water supplies used by carriers subject to interstate quarantine regulations. The 1946 revision of the 1942 standards contemplates a standard for water quality generally acceptable and applicable to all public water supplies in the United States; although no inference is meant that the authority of the



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P.H.S. should be extended to include any supplies other than those used by interstate carriers. The 1946 standards make no major changes in the basic requirements, but only a restating of certain requirements to make them more readily applicable to existing water supplies.

Among the changes are the inclusion of cross-connections and similar construction among sanitary defects; regulations for the systematic removal of sanitary defects and health hazards, and fixing responsibility for unsatisfactory conditions; requirements concerning the taking of samples, and the frequency of analysis for the presence of mineral substances; and alkalinity requirements for chemically treated waters.[A47]

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43. Combined Operation of Water and Electricity. By Earl E. Norman. Pp. 342-344.
44. New Method for Cutting Cast-Iron Pipe. By Wendell R. La Due. Pp. 345-347.
45. Automatic Operation of a Small Filtration Plant. By E. H. Greenwald and H. E. Davis. Pp. 348-354.
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February 20

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16. Training Plant Operators at Fort George G. Meade, Md. By Albert M. Tawney. Pp. 179-180.
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March 6

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21. Partial Treatment at Chicago Requires Meticulous Care. Pp. 232-233.

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January

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March

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16. Outstanding Water Bills. P. 26.
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March

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February 13

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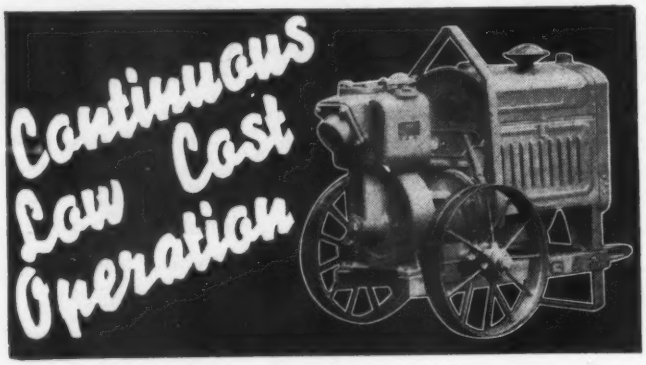

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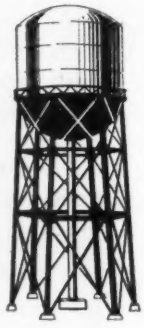

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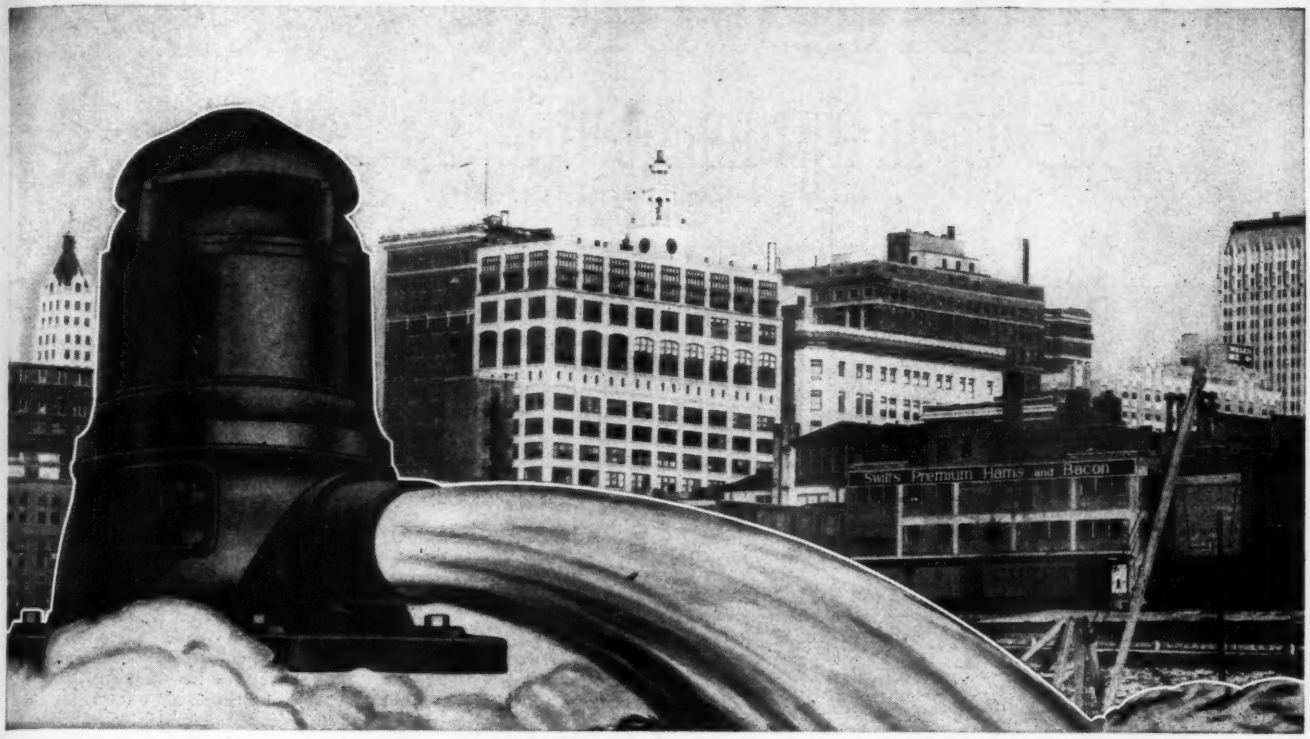

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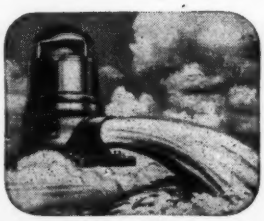

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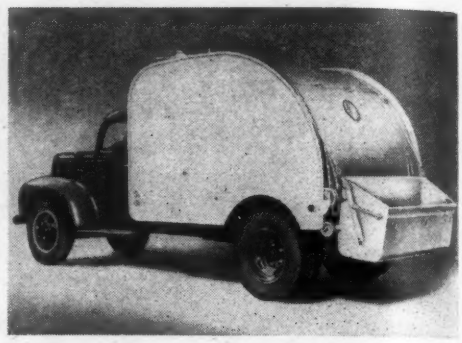

This is the new Gar Wood "bucket loader," which is a new type of enclosed refuse collector. Body sizes 6¼ or 8½ cu. yds., with hoist for dumping. Has water tight tail gate. Write Gar Wood Industries, Detroit, Mich.

Two construction uses of the versatile Jeep.

New Builders-Providence "Flo-Gage"

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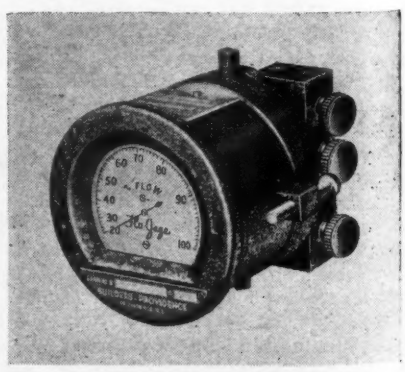

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New Pioneer Hydraulic Conveyor Truck

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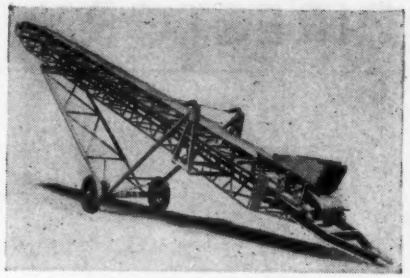

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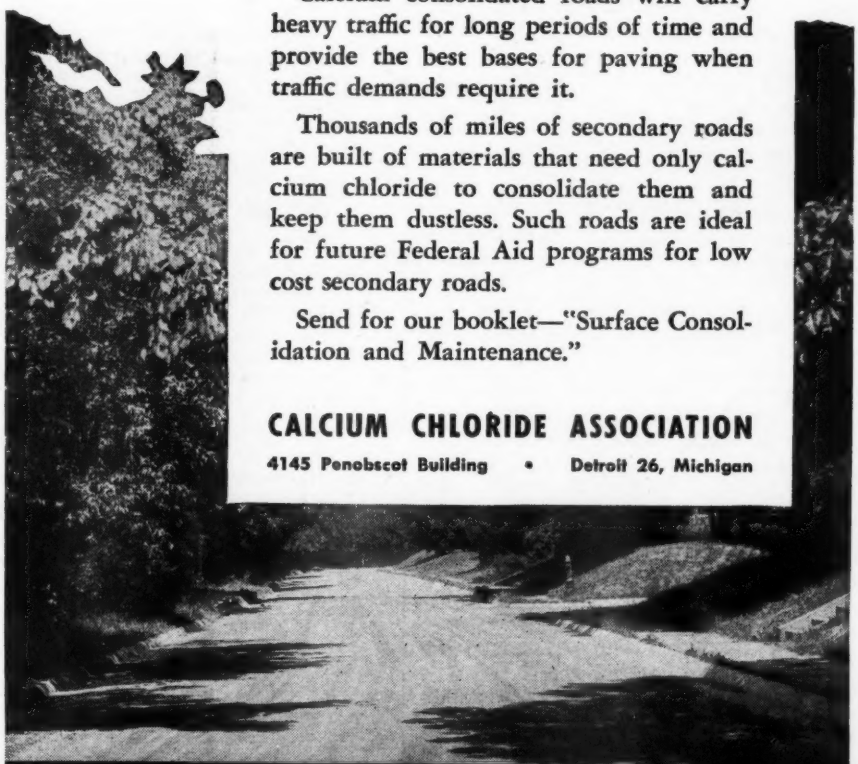

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American Public Health Association

The 74th annual meeting of the American Public Health Ass'n., will be held in Cleveland, O., the week of Nov. 11. Dr. Harold J. Knapp, Commissioner of Health, Cleveland, O., is local chairman. Dr. R. M. Atwater, is secretary of the APHA, with offices at 1790 Broadway, N. Y. 19, N. Y.

NYSSWA

The New York State Sewage Works Association will hold its Spring Meeting at Hotel Hamilton (formerly Hotel Martin) in Utica, N. Y., May 24-25, 1946.

Training Schools and Research

A practical training program in road building equipment has been established by the Heil Co., Milwaukee, Wisc., in cooperation with the Milwaukee School of Engineering. Trainees attend classes for five 8-hr. days and two evenings each week for 6 weeks. Six instructors furnished by the school conduct morning sessions in basic engineering theory and eighteen Heil Co. department heads teach practical application in the afternoon and evening periods. Field trips are made to study equipment on the job.

A research project devoted to improvement in manufacturing methods has been announced by International Harvester Co. Eight separate laboratories will be operated at this research center, which will explore, analyze and test all specific manufacturing methods or procedures within their scope. Functioning in close relationship will be a methods improvement section.

(Ed. Note: These are both excellent projects and the ideas they represent ought to be more widely adopted by industry and by municipalities.)

"Benefits From Metering" Contest

The Rockwell Manufacturing Company, Pittsburgh Equitable Meter Division, has announced two simultaneous contests designed to stimulate public thinking about the community benefits resulting from a program of metering all water services. A total of $2,000 in cash will be awarded with a first prize of $500 in each contest. Contest No. 1 requires the entrant to write the last line to a "jingle" about 100 per cent metering. Contest No. 2 is of the essay type. The contestants are asked to write a paper of 2,000 words or less on the subject "How a Community Is Benefited By Metering All Services."

Complete details, rules and regulations and entry coupons for both contests can be obtained from the company. The contests close on August 31, 1946.

Electro Rust-Proofing Corporation

Wallace & Tiernan Co., Inc., and The Dorr Company have recently purchased the interest of E. H. Ingle and have become joint owners of the Electro Rust-Proofing Corporation of Dayton, Ohio. Mr. Ingle continues as President and General Manager. The Electro Rust-

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Proofing Corporation specializes in the furnishing of equipment and engineering services for the cathodic protection of tanks and submerged metal structures in the water works and sewage fields. The company, in its 10th year, has several thousand installations throughout the U.S. and Canada. The present organization is retained and plans are being completed for expansion of research and service departments.

Free But Valuable

Reinforcing Data.—This 178-page book contains complete information on welded wire fabric for concrete reinforcement, including its use in building construction, reinforced concrete pipe, highways, airport runways and aprons, and other places. Tables. *Sent free* on request by engineers and their assistants. Ask for a copy of "American Welded Wire Fabric for Concrete Reinforcement"; mention this item; write to O. E. Stauffer, American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio.

Surface Consolidation and Maintenance with Calcium Chloride. Bull. No. 29, 1946, 58 pp., ill., Calcium Chloride Ass'n., Detroit Mich. Free.

This is another of the excellent technical pamphlets issued by the above association. Essential portions include: Planning and preparation for surface consolidation; aggregates and binder soils; test procedure for controlled proportioning; recommendations on mixture design; "rule-of-thumb" methods; essentials in mixing and placing operations; moisture; using calcium chloride; economics of maintenance and methods; using prestabilized material; other uses of stabilization; use of pycnometer for field gradation tests; and chart for determining binder material required.

Highway Maintenance Equipment, including highway brooms, pressure distributors, tank car heaters, supply tanks and trailer distributors are described in a folder, WP 1245, by Littleford Bros., Inc., 457 E. Pearl St., Cincinnati 2, Ohio.

A new bulletin by Homelite Corp., Port Chester, N. Y., pictorially describes *generators*—all of them new models. These provide power for floodlighting, operating drills or saws, public address systems, and are designed for standby service; 500 to 5,000 watt, ac or dc, 6 to 230-volt.

Chevrolet Trucks are fully described in two recent folders. One covers the light pickup truck, 115-inch wheelbase; the other, the heavy duty truck furnished with 134½ or 160-inch wheelbase.

The *Huber News,* Vol. 1, No. 1, began with the March, 1946, issue. It is "by and for the Huber organization" and Pete Howison is editor.

Personal News

(More on page 82)

Arnold G. Brown, manager of the pump division, Fairbanks, Morse & Co., Chicago, has been elected president and *Joe Downs,* of A. D. Cook, Inc., Lawrenceburg, Ind., vice-president of the National Ass'n of Vertical Turbine Pump Mfrs.

R. J. Nymberg has been made sales manager of the hoist and body division

R. J. Nymberg

of Gar Wood Industries, Inc., Detroit, Mich. He has been with Gar Wood since 1921.

F. B. Hornibrook, a nationally known authority on concrete, has been appointed assistant director of research of the Master Builders Co., Cleveland, O. He was formerly with the National Bureau of Standards.

R. F. Orth has been appointed staff manager of the Transite Pipe Section of Johns-Manville Corp. He has been with that firm since 1924, following graduation from Texas A & M College the preceding year.

G. Webber Knight has been made manager of the Washington office of the Pennsylvania Salt Co.

John Avery has been elected president and general manager of Roots-Connersville Blower Corp., Connersville, Ind., succeeding *J. S. Tatman,* who becomes chairman of the Board of Directors.

Clay pipe used as a house sewer in 3100 B.C.—5046 years ago.

Readers' Service Department

***These booklets are FREE but distribution is restricted to those actively engaged in engineering or construction. Use the coupon or write the manufacturer direct, mentioning* PUBLIC WORKS**

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Air Compressors

1. LeRoi Portable compressors in sizes from 60 to 500 c.f.m., gasoline or Diesel powered on mountings to fit your special needs. Same manufacturer makes both compressor and engine. Complete bulletin. Write LeRoi Company, 1770 So. 68th St., Milwaukee 14, Wis.

2. Jaeger air compressors, made in sizes 60 to 500 cu. ft.; trailer, truck, tractor and stationary mounted, gas, Diesel and electric power. Catalog and data. The Jaeger Machine Co., 400 Dublin Av., Columbus 16, O.

Bins and Batching Plants

11. Good illustrations and useful data on all types of Heltzel Highway Bins, for truck mixer charging, bulk cement plants, enclosed bucket elevators, belt conveyors, etc. Heltzel Steel Form & Iron Co., Warren, O.

Resurfacing Plants

15. Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus 16, Ohio.

16. Moto-paver is a new type self-contained travelling asphalt plant having a capacity of 100 to 120 tons per hour. A novel spreading and laying device permits quick change to various road widths and crown conditions and thicknesses. Write Hetherington & Berner, 729 Kentucky Ave., Indianapolis 7, Ind. for Bulletin MP46 which gives full descriptions and specifications.

Concrete, Early Strength

38. 64-page manual tells how to speed concreting, to secure high early strength and greater workability at temperatures either below or above freezing. 60 photos, charts, graphs and tables. Calcium Chloride Assn., Penobscot Building, Detroit 26, Mich.

Concrete, More Durable

50. How cement dispersion assures improved concrete with impressive economies in initial construction costs and maintenance costs. Manual from The Master Builders Co., 7016 Euclid Ave., Cleveland 3, Ohio.

Drainage Products

70. Standard corruguated pipe, perforated pipe and MULTI-PLATE pipe and arches — for culverts, sewers, subdrains, cattlepasses and other uses. 48-page booklet, No. 12. Armco Drainage Products Association, Middletown, Ohio.

Forms, Curb and Gutter

78. Curb and Gutter and Sidewalk Forms, including battered face curb form especially for modern traffic conditions. Heltzel Steel Form & Iron Co., Warren, O., will send booklets on request.

Generators

80. Two portable generators, one for AC and the other for DC current are described in new bulletin issued by Homelite Corp., Port Chester, N. Y. Commonly used for operating electrical equipment in planes, tanks and trucks, or to charge batteries or to supplement batteries for starting main engines, etc.

Graders, Patrol

98. The Austin-Western 99M Power Grader with its powerful all wheel drive handles difficult jobs with economy and efficiency; and does better work on grading, ditching, scarifying, snow ploughing, loading, mixing, bulldozing, shoulder trenching and backsloping. Write for Bulletin 1946. Austin-Western Co., Aurora, Ill.

Joints, Expansion

102. Para-Plastic hot-poured rubber joint sealing compounds and Asphalt, Fibre, Cork, Cork-Rubber, Sponge Rubber and Waterstop expansion joints are described and illustrated. Write Servicised Products Corporation, 6051 W. 65th St., Chicago 38, for a copy.

Memorial Plaques

106. Honor rolls, memorials, sculptured bas-reliefs, plaques, tablets, name plates and letters of bronze are illustrated and described in folder sent on request to Architectural Bronze & Aluminum Corp., 2342 W. Belmont Ave., Chicago 18, Ill.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and streets solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee 10, Wis.

Paving Breakers

110. Powerful self-contained gasoline hammers illustrated. Used as paving breakers and spike drivers. Easily portable, economical. Write Syntron Co., Box 220, Homer City, Pa.

Paving Materials, Bituminous

111. New "Tarvia Manual" is packed with useful data on how to build and maintain roads with Tarvia. Each step is illustrated with excellent action pictures, 64 pp. 103 illus. Write to The Barrett Div., 40 Rector St., New York 6, N. Y.

Pumps

117. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

119. "Carter Self-priming Centrifugal Pumps," a new 12-page illustrated catalog, gives detailed description of construction, and includes complete information on for bulletin #4310. Address: Ralph B. Carpump sizes, ratings and dimensions. Ask for bulletin #4310. Address: Ralph B. Carter Co., Hackensack, N. J.

Road Building and Maintenance

126. Two and Four Wheel Scrapers, Bulldozers, Tamping Rollers, Winches, Hoists and Repair Towers are subject of special bulletins issued by Gar Wood Industries, 7924 Riopelle St., Detroit 11, Mich.

128. Two powerful Galion motor graders designed to answer every requirement for more speed in road, airport, dam and housing construction work are fully described in a folder illustrated with many action pictures. Issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

130. BG Maintainer, a powerful speedy, low-priced machine for light road maintenance. Write for folder, Huber Mfg. Co., Marion, Ohio.

Rollers

141. Three-Wheel and Tandem Rollers, 5 to 8-ton and 10 & 12 ton sizes: also variable weight tandem roller for new highway surfacing and old road conditioning. Huber Mfg. Co., Marion Ohio.

Soil Stabilization

150. "High-Service, Low Cost Roads" sets forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated, 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York 6, N. Y.

152. Complete information dealing with Calcium Chloride Stabilized Roads. Contains many charts, tables and useful information. Write Columbia Chemical Div., Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh 19, Pa.

154. "Soil Stabilization with Tarvia" —An illustrated booklet describing the steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Division, 40 Rector St., New York 6, N. Y.

Spreader

187. Mix-in Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers. Adjustable Spreaders, Forms, etc. —4 complete catalogs in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus 16, Ohio.

Surface Consolidation and Maintenance

188. How sub-soils can be conditioned to resist softening and frost-action; how surfacing can be consolidated to provide smooth all-weather riding surfaces; how they can be maintained so as to prevent disintegration and gravel loss. Write the Calcium Chloride Association, Penobscot Bldg., Detroit 26, Mich., for Bulletin No. 29.

Tractors

190. International Diesel Tractors are described and many uses mentioned in 48-page catalog. Write International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill.

Maintenance Equipment

290. "Blacktop Road Maintenance and Construction Equipment" — Asphalt and tar kettles, flue type kettles, spray attachments, tool heaters, surface heaters, road brooms and rollers. This is modern and up-to-date equipment for blacktop airport and road construction and maintenance. Write for Catalog R. Littleford Bros., Inc., 452 East Pearl St., Cincinnati 2, Ohio.

Snow Fighting

Snow Plows

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

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354. Ice Prevention on Highways, Streets, and Airport Runways with Sterling "Auger Action" Rock Salt. An illustrated bulletin issued by International Salt Co., Inc., Scranton, Pa.

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357. Automatic Air Release Valves for water, sewage and industrial uses are described and illustrated in new catalog issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia 42, Pa.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York 6, N. Y.

Activation and Aeration

367. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability, 20 pp. illustrated. Sent on request to Norton Company, Worcester 6, Mass.

Bodies, Refuse

375. Gar Wood special bodies for sanitary refuse collection and for street sprinkling are illustrated and described in a new catalog issued by Gar Wood Industries. 7924 Riopelle St., Detroit, Mich.

Cleaning Sewers With Own Forces

385. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

386. 32-page illustrated booklet explains how a city can clean its sewers and culverts with its own forces using the up-to-date Flexible Sewer Rod equipment. Illustrates and describes all necessary equipment. Issued by Flexible Sewer Rod Equipment Co., 9059 Venice Boulevard, Los Angeles 34, Calif.

387. Literature illustrating how cities, towns and villages using OK Champion Sewer Cleaners are doing a complete sewer cleaning job from street level. Three sizes of machines available in addition to full line of sewer rods and accessories. Issued by Champion Corporation, 4752 Sheffield Avenue, Hammond, Indiana.

Corrosion Prevention, Water Tanks

390. "Preventing Corrosion of Steel Water Storage Tanks" is the subject of an interesting, illustrated bulletin issued by Electric Rust-Proofing Corp., Dayton 10, Ohio. Gives full description of Rustop System of prevention.

Corrosion Resistant Metal

391. "Everdur Metal" is title of an 8-page illustrated booklet describing advantages of this corrosion-resisting alloy for sewage treatment equipment, reservoir, and waterworks service. The American Brass Company, 25 Broadway, New York.

Diesel Engines

392. 20-page catalog describes "Dieselectric" plants 3 to 10 KVA, and diesel engines from 4 to 12 H.P. These are easily transported and will produce reliable, low cost light and power anywhere. Write WITTE ENGINE WORKS, Division of Oil Well Supply Company, Kansas City 3, Mo.

393. Small Diesel engines—down to 3¾ HP. The only stationary Diesel that is air-cooled. For full details on this revolutionary engine for municipal service write R. H. Sheppard Co., 150 Middle St., Hanover, Pa.

394. "Blue Streak" engines for 425 and 495 hp are described in Bulletin No. S 329; also Bulletins SA 341 and 342 for small and medium power service. Write Climax Engineering Co., 111 W. Monroe St., Chicago, Ill.

Feeders, Chlorine, Ammonia and Chemical

399. Feeders of all types including Hypochlorinators, Reagent Feeders, Dry Chemical Feeders, Chlorinators and Ammoniators for feeding all of the usual chemicals used in sanitation practice—manufactured by Wallace & Tiernan Co., Newark 1, N. J.

400. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. %, 96 Codding St., Providence 1, R. I.

401. Gravimetric Feeder, Loss-in-weight type, measures and feeds dry or liquid materials by weight. Illustrated bulletin. Omega Machine Co., Inc., 96 Codding St., Providence 1, R. I.

Filters, Sludge

403. For bulletins on Vacuum Filters for dewatering primary, activated, digested or chemical sludge, write The Conkey Co., 420 Lexington Ave., New York 17, N. Y.

Fire Hydrants

405. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Anniston, Ala.

Flow Meters

409. The primary devices for flow measurement—the orifice, the pitot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (C42A). Simplex Valve and Meter Co., 6750 Upland St., Philadelphia 42, Pa.

Gas Engines

411. For information on the use of Climax engines with sewage gas for developing power around the sewage plant write Climax Engineering Co., 111 W. Monroe St., Chicago, Ill.

Gas Holders

412. A 16-page bulletin gives detailed information on the development of corrosion—and how to combat it—in gas holders. A copy will be mailed on request to The Stacey Bros. Gas Construction Company, 5535 Vine St., Cincinnati 16, Ohio.

Gates, Valves, Hydrants

413. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

Generating Sets, Diesel

422. New booklet describes Sheppard Diesel Generating Sets that make low cost electricity from cheap fuel and give dependable service in the hands of any average operator. Write R. H. Sheppard Co., 250 Middle St., Hanover, Pa.

Laboratory Equipment

423. pH and Chlorine Control. A discussion of pH control and description of comparators, chlorimeters and similar devices. An 80-page booklet, W. A. Taylor & Co., 7301 York Road, Baltimore 4, Md.

425. "Replaces 'old fashioned' Methyl Orange Indicator" is sub-title of new folder on pH control by new Fleisher Methyl-Purple Indicator. Sharp, clear and positive end points of green and purple insures more accurate and quicker results. Issued by Fleisher Chemical Co., Benjamin Franklin Station, Washington 4, D. C.

Manhole Covers and Inlets

429. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., Lafayette Boul, and Indiana Ave., South Bend 23, Ind.

Meter Setting and Testing

431. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 48-page booklet you should have a copy of. Ask Ford Meter Box Co., Wabash, Ind.

Meters, Venturi

432. New bulletin illustrates Builders Air Relay system for liquids containing suspended solids like sewage. Eliminates corrosion, clogged pipes, etc. "The Selection of Main Line Meters," a highly informative and useful presentation, describes forms of differential producers and quickly solves typical problems with the use of graphic charts. Write Builders-Providence, Inc., 9 Codding St., Providence 1, R. I.

Meters, Water

434. "Watchdog" water meters, made in standard capacities from 20 GPM up; frost-proof or split case in household sizes. All parts interchangeable with present models of same manufacturer. For bulletins, write Worthington-Gamon Meter Co., 282-296 South St., Newark, N. J.

Pipe, Cast Iron

436. Handbook of Universal Cast Iron Pipe and Fittings, pocket size. 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., 386 Fourth Ave., New York 16, New York.

437. Cast iron pipe and fittings for water, gas, sewer and industrial service. Super-deLavaud centrifugally-cast and pit-cast pipe. Bell-and-spigot, U. S. Joint, flanged or flexible joints can be furnished to suit requirements. Write U. S. Pipe and Foundry Co., Burlington, N. J.

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Write for Bulletin No. 213 containing full information, including engineering data which shows why the P.F.T. is by far the preferred rotary distributor.

P.F.T. PACIFIC FLUSH-TANK CO.
4241 Ravenswood Ave., Chicago, Ill.
NEW YORK—CHARLOTTE, N. C.

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They've added a New Member to the Big Stuart-Brumley Family—

THE AUTOMATIC WATER SAMPLER • •

Entirely automatic, refrigerates the samples, needs no operator, keeps samples contamination-free, operates 24 hours a day. *Stop by Booth 35 in St. Louis to see one in operation.* Also to learn of other items, including **"ELECTRONIC COAGULATOR."**

STUART-BRUMLEY CORP., 516 N. CHARLES, BALTIMORE, MD.

438. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Pipe Forms

440. Making concrete pipe on the job to give employment at home is the subject of a booklet sent promptly on request by Quinn Wire & Iron Works, 1621 12th St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms.

Pipe Pusher

444. One-man-operated Hydraulic Pipe Pusher pushes pipe through ground under streets, sidewalks, lawns and other obstacles. Pays for itself in man hours saved on first few jobs. For complete facts and prices, ask for booklet S-117, Greenlee Tool Co., 2042 Columbia Ave., Rockford, Ill.

Pumps, Sludge

451. Plunger Sludge Pumps are described in bulletin #4502, just released for publication. This new eight-page catalog shows detail photos of construction of a Carter unit, and gives complete information including specifications, motor selection, capacities, dimensions, weights and sizes of the various single and multiple plunger pumping sets manufactured by the Ralph B. Carter Co., Hackensack, N. J.

453. Specialized pumps for sewage, sludge, water supply, circulation, condensation. Vertical, horizontal, centrifugal units. A separate bulletin for each type. Request bulletins by type of pump from Yeomans Brothers Company, 1425 North Dayton Street, Chicago 22, Illinois.

Pumps and Well Water Systems

454. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis 8, Tenn.

455. Peerless deep well pumps in a variety of types, with oil or water lubrication and any power drive, to pump water from any depth. Write Peerless Pump Div., Food Machinery Corp., 301 W Ave. at 26th St., Los Angeles 31, Calif.

456. Oil lubricated turbine pumps with open impellers. Five types of heads available. Specifications and illustrations in new bulletin 6930M-2 issued by Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.

457. Centrifugal Pumps of various designs—single-stage, double-suction, split casing; single-stage single-suction; two-stage opposed impeller; three-stage; high-pressure; fire pumps; close-coupled. A bulletin for each type. Peerless Pump Div., Food Machinery Corp., Quincy, Ill.

Rubbish Collection

459. For saving trucks, labor, and time in city rubbish collection get details of the new Dumpster-Kolector described in literature just published by Dempster Brothers, Inc., Knoxville 17, Tenn.

Screens

460. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and inclined types). Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia 40, Pa.

Sludge Drying and Incineration

463. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Plainfield National Bank Bldg., Plainfield, N. J.

Softening

467. Water Softening. The use of the Spaulding Precipitator to obtain maximum efficiency and economy in water softening is described in a technical booklet. Permutit Co., 330 W. 42nd St., New York 18, N. Y.

Sprinkling Filters

469. Design data on sprinkling filters of Separate Nozzle Field and Common Nozzle Field design as well as complete data on single and twin dosing tanks, and the various siphons used in them, for apportioning sewage to nozzles. Many time-saving charts and tables. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago 13, Ill.

Swimming Pools

472. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Taste and Odor Control

474. Technical pub. No. 207 issued by Wallace & Tiernan Co., Inc., Newark 1, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination. Sent free to any operator requesting it.

475. "Taste and Odor Control in Water Purification" is an excellent 92-page, illustrated booklet covering sources of taste and odor pollution in water supplies and outlining the various methods of treatment now in use. Every water works department should have a copy. Write Industrial Chemical Sales Div., 230 Park Ave., New York 17,, N. Y.

Treatment

476. Are you familiar with the new, revolutionary "Rim-Drive" Clarifier? "Rim-Drive" eliminates costly mechanism and installation, and reduces maintenance costs. Write Yeomans Brothers Company, 1425 North Dayton Street, Chicago 22, Illinois, for the complete design details, capacities and installation illustrations.

477. The Yeomans "Package" Aerifier" plant is especially designed for communities up to 3,000 population. This attractive, efficient plant, which features mechanically combined aeration and final clarification in a single tank, is described in Bulletin 6650. Write Yeomans Brothers Company, 1425 North Dayton Street, Chicago 22, Ill.

480. Booklet No. 1642 on Link-Belt Circuline Collectors contains sanitary engineering data and design details. Catalog No. 1742 on Straightline Collectors, contains layout drawings, installation pictures and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia 40, Pa.

482. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, 570 Lexington Ave., New York 22, N. Y.

486. 28-page catalog describes and illustrates the Dorrco Hydro-Treator, a self-contained water treatment unit combining Flocculation, Sludge Thickening and Clarification. Reduces treatment time and lowers plant construction costs. The Dorr Co., 570 Lexington Ave., New York 22, N. Y.

488. "Packaged" Sewage Treatment Plants specifically developed for small communities — 100 to 3,000 population. Write for full description and actual operating data for this type of plant. Chicago Pump Co., 2438 Wolfram St., Chicago 18, Ill.

489. Illustrated and described in detail in this bulletin, the new Carter Improved Flocer presents an entirely new method of controlled flocculation without paddle agitation. Write Ralph B. Carter Co., Hackensack, N. J.

490. New bulletin fully describes and illustrates Hardinge sludge collectors for clarifiers, sludge concentration and skimming in both circular and rectangular tanks. Write Hardinge Company, Inc., York, Pa.

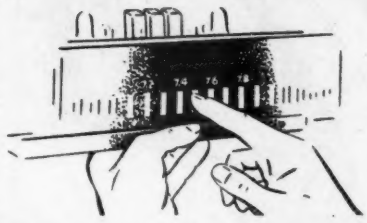
Water Treatment

496. "Use of copper sulphate in water treatment plants" contains valuable data on chemicals, dosage, etc. Ferri-floc Ferric Sulphate—a new, valuable booklet on coagulation for water and sewage treatment plants. Write Tennessee Corporation, Atlanta 1, Ga.

Water Service Devices

506. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., will be sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati 2, Ohio.

A TWO-MINUTE CHECK may save a TWO-DAY REPAIR JOB!



Taylor's completely portable High and Low Phosphate Comparators enable you to determine residual phosphate, easily and simply and accurately . . . in TWO MINUTES! Both sets work on the same Taylor base (which also accommodates Taylor standard slides for a 1-minute check on pH). The High Phosphate color standard slide contains 9 standards, from 5 to 100 ppm of phosphate as PO_4; the Low Phosphate color standard slide contains 9 standards, from 0 to 25 ppm. All Taylor liquid color standards (enclosed in plastic slide) carry AN UNLIMITED GUARANTEE against fading. Either set, with complete accessories, $19.00. In wooden carrying case, $26.00.

See your dealer today, or write direct for 88-page book giving details about Taylor Phosphate and Poly Phosphate Sets (Hexameta, Pyro, Septa, etc.)

W. A. TAYLOR AND CO.
7304 YORK RD. • BALTIMORE-4, MD.

Invaluable!

- In making a *complete* test of a water meter you should know the volume of water, the meter registration caused by this volume, AND the rate of flow in gallons per minute at which test was made.
- The Ford Testerate Indicator will show this rate of flow instantly and accurately. For complete meter testing it is truly invaluable.
- Information for the asking.

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Meter Box Co.,
WABASH, INDIANA

FOR RELIABLE LABORATORY CONTROL—

ACCURATE
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Replaces *"old fashioned"* Methyl-Orange Indicator

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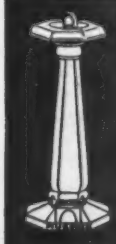

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Because they give years of practically trouble-free service.

Would you like to have a copy of Catalog "L"? Write The Murdock Mfg. & Sup. Co., Cincinnati 2, Ohio.

MURDOCK

SELF-CLOSING ANTI-FREEZING HYDRANT

ANTI-FREEZING COMPRESSION HYDRANT

LARGE ANTI-FREEZING HYDRANTS 1½" TO 2" INCLUSIVE

PERSONAL NEWS

Gail A. Hathaway of the office of Chief of Engineers, U. S. Army, has become vice-president of the American Society of Civil Engineers, succeeding A. C. Polk of Birmingham, Ala., who died recently.

A. W. Fulton has returned to the sales staff of Athey Products Corp., Chicago, after serving overseas as an officer of the Navy.

Morris M. Cohn, well-known sanitary engineer of Schenectady, has been appointed advisor-at-large to the State of Vermont in stream pollution abatement.

Roger W. Loveless, formerly major, Sn. C., has become a member of the firm of Alden E. Stilson and Associates, Columbus, O.

Ralph G. Kazmann, formerly of the Ground Water Division, USGS, has been appointed hydrologic engineer of the Ranney Method Water Supplies, Inc., Louisville, Ky.

Col. Michael J. Blew, Sn. C., has been awarded a commendation for the superior performance of his duties as sanitary engineer, Office of The Surgeon, Fourth Service Command, U. S. Army. Col. Blew has been responsible for control of malaria, supervision of water supplies and waste disposal, and all other sanitary engineering problems for the Army in the seven southeastern states since 1941.

Major John Carollo, Sn. C., member of the firm of Headman, Ferguson, Carollo and Classen, consulting engineers of Phoenix, Ariz., has been awarded the Legion of Merit for his work in determining methods for the removal, and the toxicity, of DDT in water.

Robert E. Gray has been appointed assistant to the chief engineer of the Ohio State Highway Department. Mr. Gray was released by the Army early this year after 3½ years service with the Corps of Engineers. *Charles Bonfield* has resigned as Division Engineer to enter industry.

Kenneth F. Park, long with Caterpillar Tractor Co., and an outstanding contributor to advancement in earth-moving, has been made consultant to Caterpillar on all matters pertaining to earth-moving.

William F. Newton has been appointed manager of research and development for the Columbia Chemical Division of Pittsburgh Plate Glass Co.

Edward M. Wilson, recently released from the Army (Captain CWS), has returned to the Pennsylvania Salt Mfg. Co., as Philadelphia District Sales Manager, of heavy chemicals division.

JOBS AVAILABLE

Sales engineer to represent water works equipment manufacturer in Illinois and Indiana. Write Col. Hardenbergh, this magazine. (GFA1).

Other potential openings are also available in sales or drafting. Write this magazine, attention Col. Hardenbergh.

Advertising Index

Albright & Friel, Inc. 76
Alvord, Burdick & Howson 76
American Brass Co. 7
American Photocopy Equipment Co. 61
Armco Drainage & Metal Products, Inc. 5

Baker, Jr., Michael 76
Banister Engineering Co. 76
Barrett Division 11
Black & Veatch 76
Bogert-Childs Engineering Assoc. 76
Briggs & Stratton Corp. 67
Buck, Seifert & Jost 76
Buffalo Springfield Roller Co. 60
Builders-Providence, Inc. 69
Burrill & Assoc., Harold G. 76

Caird, James M. 76
Calcium Chloride Assn. 75
Carter Co., Ralph B. 14
Central Foundry Co. 13
Champion Corp. 65
Chester Engineers 76
Chicago Tank & Bridge Co. 72
Climax Engineering Co. 50
Cole & Son, Chas. W. 76

Dorr Co., The 16
Dow, A. W., Inc. 76
Dresser Division 46

Electro Rustproofing Corp. 49
Everson Mfg. Co. 54

Fitch Recuperator Co. 58
Fleisher Chemical Co. 82
Flexible Underground Pipe-Cleaning Co. 4
Flink Co., The 62
Ford Meter Box Co. 81
Ford Motor Co. 15
Frink Mfr., Carl H. 61

Gannett, Fleming, Corddry & Carpenter, Inc. 76
Gar Wood Industries, Inc. 55
General Amer. Trans. Corp. 43
General Chemical Co. 57
Goff, William A. 76
Goodwin Engrg. Co., J. W. 76
Gorman-Rupp Company 72
Graver Tank & Mfg. Co. 10
Greeley & Hansen 76
Green Co., Howard R. 76
Greenlee Tool Co. 71

Hardinge Co., Inc. 66
Hill & Hill 76
Homelite Corp. 63
Hotel Philadelphian 58
Huber Mfg. Co. 2

Industrial Chemical Sales Div. 17
Infilco, Inc. 41
Inst. Tr. Mun. Admin. 76
International Harvester Co. 9

Jaeger Machine Co. 61 & 63
Johns-Manville Corp. 8

Koehring Company 65

Layne & Bowler, Inc. 73
Link Belt Company 18
Littleford Bros., Inc. 64
Lozier & Co., Wm. S. 76

Mathieson Alkali Works (Inc.) 35
Metcalf & Eddy 76
M & H Valve & Fittings Co. 77
McWane Cast Iron Pipe Co. 49
Mueller Company 12
Murdock Mfg. & Supply Co. 62

National Lime Assn. 40
National Water Main Cleaning Co. 6

Pacific Flush Tank Co. 80
Peerless Pump Division 70
Permutit Co. 37
Pirnie, Malcolm 76
Pitometer Co., The 12
Proportioneers, Inc. F C

Quinn Wire & Iron Works 65

Rensselaer Valve Co. 83
Robert & Co., Inc. 76
Roberts Filter Manufacturing Co. 51
Russell & Axon Cons. Engrs., Inc. 76

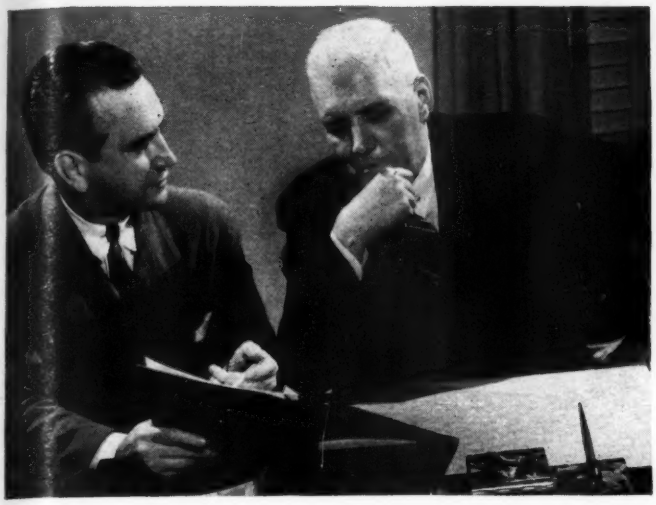
Servicised Products Corp. 14
Simplex Valve & Meter Co. 39
Sirrine & Co., J. E. 77
Snell, Inc., Foster D. 77
Solvay Sales Corp. 36
South Bend Foundry Co. 77
Stacey Bros. Gas Construction Co. 53
Stanley Engineering Co. 77
Sterling Machinery Corp. 77
Stewart, W. H. 78
Stilson & Assoc., Alden E. 77
Stuart Brumley Corp. 80

Taylor Co., W. A. 81
Taylor, Henry W. 77
Tennessee Corp. 72

U. S. Pipe & Foundry Co. 67

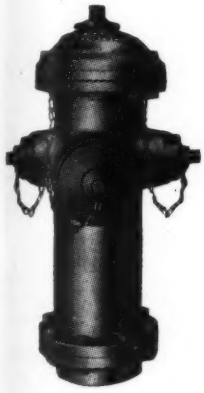
Wallace & Tiernan Co., Inc. B C
Weston, L. A. 65
Witte Engine Works 61
Wood Co., R. D. 66

Yeomans Brothers Co. 3



"I thought you said there's a difference between valves"

Rensselaer Valve Man (surprised): That's right, Tom, I did—and I do. What's up?

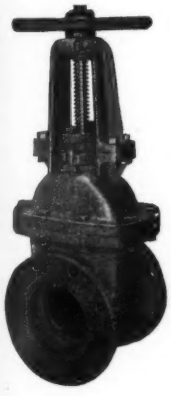


Water Works Exec. (half seriously): Well, you've kept me sold on your valves for a good many years; you convinced me they had the best design, and quality of material and workmanship. So we've been standardized.

R.V.M.: That's right, you sure have—for more years than either of us like to admit.

W.W.E.: Well, I'm not afraid to admit my age, Bob, but it's never too late to learn. During the war emergency I was forced to pick up some valves from surplus stocks. Never heard of a few of these before, but they seem to work O.K.—Why should I use yours?

R.V.M.: You had me worried at first Tom; I thought you were serious—or do I really need to remind you why you switched to Rensselaer in the first place? Remember the hodge-podge you once had—many of them "orphans"? Remember the ones you couldn't close, the Stems that failed, the Gates that dropped, the Wedges that broke—and the trouble getting repair parts? Now most of those are replaced—and according to my records your troubles have just about disappeared with them. Seems to me I heard you bragging about that to the Mayor the other day.



W.W.E.: Ouch! Guess I'm guilty. Maybe you are right at that. No reason any valve shouldn't work fairly well when it's new—there's more to it than that. I'm building for the future—not just for today. When the man on this job 50 years from now thinks of me, I want him to say, "Good old Tom Jones" not "If that fellow Jones had just used some sense back when all that Post-War work was done, half of our present headaches could have been eliminated".

R.V.M.: Amen! Tom, you're a better salesman than I am.

RENSSELAER VALVE COMPANY, TROY, N. Y.

Atlanta, Ga. Chicago, Ill. Haverhill, Mass. New York, N. Y. Los Angeles, Cal. Philadelphia, Pa. Pittsburgh, Pa.
San Francisco, Cal. Memphis, Tenn. Waco, Texas Seattle, Wash.

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Fortunate, indeed, is the water plant with a complete record of operations — records to guide future plans, to furnish information on treatment questions and as evidence of past performance. Now — W & T offers equipment to fill in an important gap in your operating records — the Chlorine Residual Recorder. Now — you can have a permanent month after month record of the actual total chlorine residual maintained at any point.

The Chlorine Residual Recorder — the Chlorination Sentry — New Flow Recorders and other new W & T Developments together with time-tested Visible Vacuum Chlorinators will be on display at the A.W.W.A. Conference in St. Louis. We'll be looking for you in booths 53, 54 and 55.

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WALLACE & TIERNAN COMPANY, INC.

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